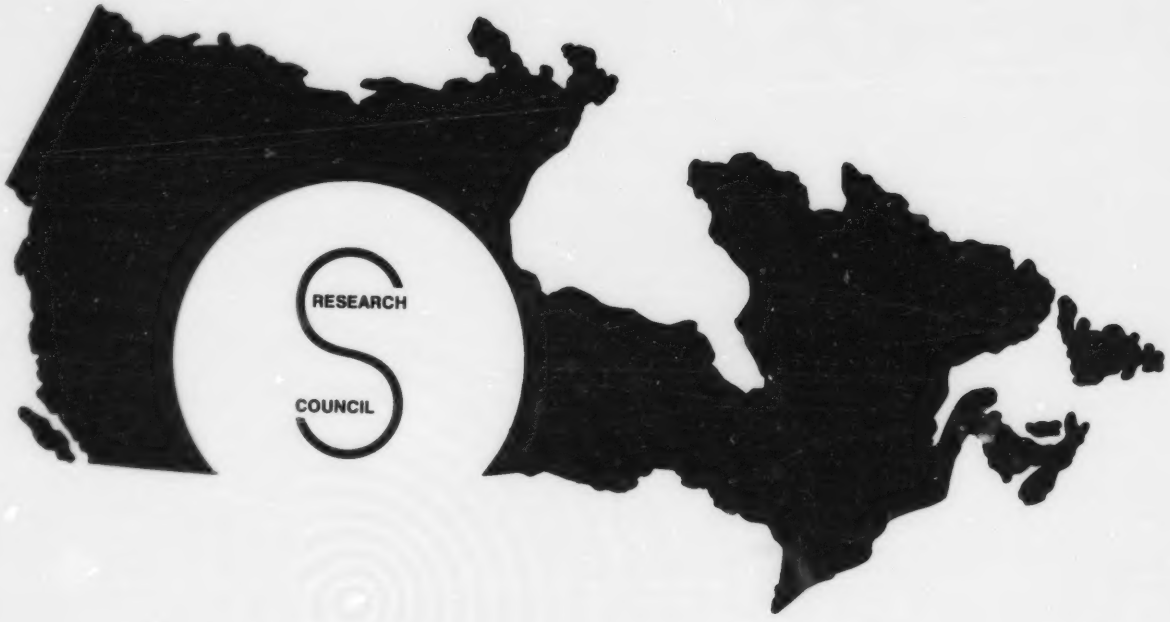
Sask
Research Council



SASKATCHEWAN RESEARCH COUNCIL
28TH ANNUAL REPORT 1974

THE RESEARCH COUNCIL ACT, 1965,
Clause 21, in part, directs that:

1. The Council shall on or before the last day of February in each year submit to the Lieutenant Governor in Council a report of its proceedings and transactions during the next preceding calendar year, which report shall contain such particulars as the Lieutenant Governor in Council may prescribe.

2. Every report shall forthwith be laid before the Legislative Assembly if then in session or, if it is not in session, within fifteen days after the opening of the next session.

Regina, February 20, 1975

●

TO THE HONOURABLE S. WOROBETZ

Lieutenant Governor of the
Province of Saskatchewan

MAY IT PLEASE YOUR HONOUR:

The undersigned presents herewith, for your consideration, the report of the Saskatchewan Research Council for the year ended December 31, 1974.

Respectfully submitted,

Gordon MacMurchy, Chairman
Saskatchewan Research Council

PLEASE ADDRESS CORRESPONDENCE TO:

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N 0X1

102-00006/

COUNCIL DIRECTORS, gathered at a regular meeting include (front row, left to right) B. M. Craig, G. Gartner (vice-chairman), Hon. G. MacMurchy (chairman), D. Bock (secretary), J. H. Archer. (back row, left to right) K. J. McCallum, A. Kavadas, C. G. Mitchell, J. E. Fletcher, D. Pichler. Missing were N. Bromberger, E. B. Campbell, D. F. McArthur, K. O. Saddlemyer.

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MEMBERS OF THE SASKATCHEWAN RESEARCH COUNCIL

The Honourable Gordon MacMurchy, Chairman
G. J. Gartner, Vice Chairman
D. Bock, Secretary
J. H. Archer
N. Bromberger
E. B. Campbell
B. M. Craig
J. E. Fletcher
A. Kavadas
D. F. McArthur
K. J. McCallum
G. C. Mitchell
D. Pichler
K. O. Saddlemyer

EXECUTIVE OFFICERS OF THE COUNCIL'S STAFF

Director	T. P. Pepper
Administrative Officer	R. E. Melvin

Division Heads

Chemistry	Brad H. Gunn
Engineering	W. H. W. Husband
Geology	R. G. Arnold
Industrial Services	I. S. Evans
Physics Division	J. Maybank

PROCEEDINGS OF THE COUNCIL

During the year there has been considerable change in the membership of Council, its committee structure, and its mode of operation.

Council membership has decreased from 19 to 14. The following 14 members left Council during the year: B. W. Currie, J. Roe Foster, R. N. H. Haslam, C. A. L. Hogg, W. H. Horner, J. M. Mantle, E. R. Olson, R. H. D. Phillips, K. W. Setter, J. W. T. Spinks, R. V. Tomkins, A. B. Van Cleave, C. R. Webster, and J. G. Wotherspoon.

The Council expressed high appreciation of the services of these gentlemen.

Mr. G. C. Mitchell was reappointed to Council.

The following persons have been appointed to Council: D. Bock, N. Bromberger, E. B. Campbell, B. M. Craig, J. E. Fletcher, A. Kavadas, D. F. McArthur, K. J. McCallum, D. Pichler.

The Council met three times during the year; on February 25th, on June 12th and November 13th in Saskatoon. The main business of these meetings was to reorganize the committee structure of the Council, to formulate policy and priorities for the program of the laboratories, to approve the 1974-75 program, and to recommend the 1975-76 program.

The former Appointments and Technical Committees were replaced by an Executive Committee, whose members are presently, the Executive Officers of Council, (i.e. the Hon. G. MacMurchy, Chairman, G. Gartner, Vice-Chairman, and D. Bock, Secretary) and B. W. Craig, with T. P. Pepper as Committee Secretary. The Executive Committee met six times, on May 21, June 25, July 25, September 24, October 6 and October 17, 1974. The main activities of the Executive Committee were to deal with routine administrative matters of the laboratories and, in conjunction with Council management, to prepare laboratory program details for discussion by Council.

The former Forward Planning Committee was discontinued, since Council itself will be the forum for discussion of the purpose of the laboratories and for priorizing its program.

1974 IN REVIEW

During 1974 new and positive steps were taken to restructure the Saskatchewan Research Council's work in terms of user needs. While the Council has always been conscious of its role in applied science and technology for the benefit of Saskatchewan and its people, the new emphasis on program areas is designed to achieve better co-ordination with users of science and technology.

Major program areas identified include:

- agriculture,
- resource development,
- industrial development,
- environmental quality.

While SRC has retained its discipline-oriented internal organization, the program areas furnish logical contact points for final users of Council services. By careful consideration of user needs in various program areas, it is easier for Council to achieve the necessary balance between projects to meet immediate needs and those projects designed to meet problems anticipated in the future.

The soaring cost of feed grain has prompted accelerated effort in Council projects dealing with improving the digestibility of low quality hay. Better utilization of alfalfa, involving the separation of the high-protein leaves from the energy-rich stalks, holds promise of more economic and efficient feeding of Prairie cattle. Protein concentrates, suitable for livestock feeds and possibly for direct human consumption, can be prepared from the leaves while treated stalks are a potential high quality feed material.

As the price of pesticides rises it becomes of even greater urgency that farmers apply sprays effectively. A program with a double thrust — that of more effective weed control combined with pollution abatement — was continued at SRC during the past year. Investigation of spray patterns from aircraft was featured in the 1974 investigations.

Potential pollution hazards from feedlots in the Qu'Appelle basin are also under study. This problem is a rather difficult one because a fairly large number of rather small potential pollution sources are involved. Results from this study could form a basis for establishing pollution abatement strategies for the deteriorated environment of the Qu'Appelle.

A FALCON AIRCRAFT from the Canada Centre for Remote Sensing carries a sophisticated, multi-million dollar payload of instrumentation. SRC investigators have made extensive use of remote sensing methods in environmental impact assessment and resource development studies.

Energy resources in the form of lignite coal have been under active consideration by SRC since 1971 in various joint programs involving the federal and provincial governments and the Saskatchewan Power Corporation. Results from these studies have established the magnitude of the resource that can be economically mined under present market conditions as in excess of 7.5 billion tons. Since market conditions at present are highly volatile, SRC has established a computer data base containing pertinent geological and chemical data concerning Saskatchewan lignite so that the economics of particular coal seams can be quickly appraised by mines economists.

The payoff from this lignite activity is apparent from the sequence of events including the location of a major coal seam in the Fife Lake-Coronach

area in 1971, the subsequent detailed investigation of 10 sections of land near Coronach and culmination in the September 1974 announcement of SPC of a proposed generating station and strip mine near Coronach.

Water resources are essential to almost every kind of development. Many Saskatchewan communities have adequate quantities of water but the quality is poor due to natural salinity. Saskatchewan winters provide free refrigeration which can be used to reduce the salt content through the natural method of freezing the water in winter and melting it in spring. Since the quality of water obtained from freeze desalination depends on both the chemistry of the local water and the climate, nine large scale trials of the process were carried out at five sites during the winter of 1973-74. In eight of the nine trials, 70 per cent of the water produced met Environment Saskatchewan tolerance limits for drinking water of 1,500 parts per million salinity, or less. Further work at these five sites is under way during the winter of 1974-75.

COMPLEX ARRANGEMENTS of earth materials overlie zones of economic mineralization in northern Saskatchewan. Earl Christiansen examines a sequence showing (from the top) bouldery glacial till, mixed sands and gravels, silt, then gravel. Information concerning nature of the surficial materials is useful in planning geological exploration and for construction projects.

Many of Saskatchewan's manufacturing industries employ welding processes on their production lines. Visits to 43 welding establishments and discussions with Kelsey Institute welding instructors and officials of the Department of Labor's apprenticeship branch established the state of the art in Saskatchewan. With support from the National Research Council and the Canadian Welding Improvement Bureau, a welding specialist has been added to the Council staff. The potential payoff from this activity is high: one firm alone can realize

ANIMAL FEEDING TESTS, carried out at University of Saskatchewan facilities, provide essential information for evaluating new animal feed materials. Feed test results are a key factor in design of large-scale straw processing methods.

a saving of $25,000 yearly by introducing an inert gas welding operation and also produce stronger welds.

At present, limestone and lime, used in Saskatchewan steel mills, pulp mills, water treatment plants and in the construction industry at a rate of about 280,000 tons per year, is imported from other provinces. A deposit of marl, a soft, earthy form of limestone, at Sturgeon Lake would be suitable for most of these applications if it could be economically recovered. During the past year SRC developed a recovery process under contract with the Department of Industry and Commerce and Saskatchewan Minerals.

Through its free and confidential industrial engineering and technical assistance programs, SRC has promoted industrialization. Some examples of work during the past year include:

— recommendations regarding layout changes at a metals plant which led to an increase of $50,000 per year in profits and the creation of new jobs;
— a five-fold increase in weekly production rate at a manufacturing plant through the application of improved scheduling techniques;
— savings of $25,000 annually to a manufacturer

COUNCIL MANAGEMENT consists of division heads (standing left to right) R. G. Arnold, geology; I. S. Evans, industrial services; J. Maybank, physics; (seated, right) Brad Gunn, chemistry; T. P. Pepper, director; R. E. Melvin, administrative officer; and W. H. W. Husband, engineering.

ENVIRONMENTAL DATA in massive amounts are generated from SRC work programs. Data concerning water analyses at more than 1,000 Saskatchewan sites, coal analyses from 400 points and weather information at 300 places are held in the data banks. Charles McKenzie is shown running a program to use part of these data.

of prefabricated buildings through consultation with specialists;

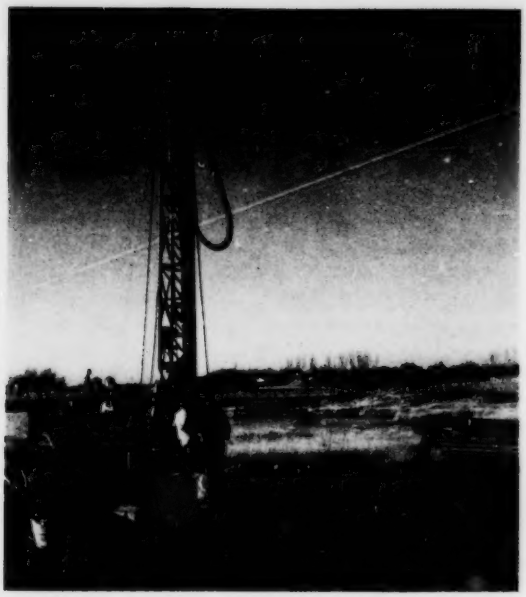
— an immediate saving of $5,000, plus an improved product, to a fibre glass firm.

Support from the National Research Council is a key factor in maintaining the technical information and industrial engineering projects at SRC.

The interaction between environment and development is most complex. During the past year the Council was involved with 21 projects concerned with defining the environment or correcting specific environmental problems. Problems concerning grain dust originating from elevators were investigated with support from the Atmospheric Environment Service. The expertise and equipment required for this study were analogous to those required for the study of pesticide drift. An investigation of the groundwater aquifers, which supply a major portion of the water to Regina and Yorkton, required data from an SRC climatological project to complete the interpretation.

Environmental studies of the Meadow Lake Provincial Park were undertaken for the Department of Tourism and Renewable Resources to aid in planning park development. Information gathered for this purpose is being compiled for

GEOPHYSICAL EQUIPMENT such as this electric logging outfit, were extensively employed in coal resource evaluation. Other agencies, such as the Department of Mineral Resources, Saskatchewan Power Corporation and Department of Energy, Mines and Resources have supported various aspects of the lignite study.



FEEDLOT WASTES pose a threat of water pollution. Bill Meneley of SRC (right) discusses the set up for an observation well with driller Carl Higgins. A natural waste disposal pond and the feedlot buildings are seen in the background.

presentation in a brochure to acquaint tourists with history of the park landscape.

During 1974, an increased measure of the Council's effort was directed towards activities in the north. Mineral exploration of Saskatchewan's northland has had a long and difficult history due to the vastness of the area, difficult access and overburden materials that conceal deposits of possible economic importance. SRC has led in employing geochemical techniques to gain clues concerning mineral deposits from analyses of soil samples, lake sediments and vegetation. Tracing of mineralized boudler trains in overburden back to their source has led to the location of a second mineralized zone on a lead-zinc property at George Lake, 180 miles northeast of La Ronge.

NATURAL ELECTRICAL POTENTIALS provide a novel geophysical prospecting technique for investigating mineralization near George Lake. Ben Morrison arranges his equipment to make a measurement.

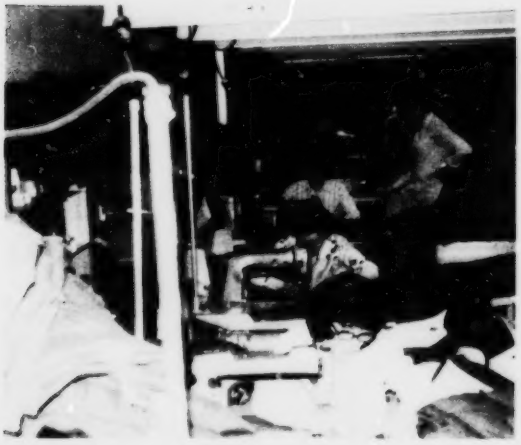
Another project is concerned with mapping the glacial deposits constituting the overburden material. Data from this program, carried out in the La Ronge area are useful in structural design and gravel location as well as in mineral exploration. More clues concerning potential economic mineral deposits can be obtained from the study of volcanic rocks which are often associated with major mineralization. A program in the Amisk Lake area has furnished new insights into the basic geology of the area.

ICE MOUNDS, built by spray freezing techniques, can supply drinking water to farms and communities where excessive salinity of available water is troublesome to the residents. Large areas of Saskatchewan experience problems with excessive natural salinity in water.

Baseline surveys of the aquatic environment are necessary to the licensing of major developments in the north, such as the establishment of mines or dams. Areas under SRC investigation during the past year included the Churchill River, Tobin Lake and Cluff Lake. Demands for Council services in regard to environmental impact assessment are experiencing a growing trend.

To enhance the quality of life in the north the Department of Northern Saskatchewan has undertaken a long-term program of supplying sewer and water services to 15 northern communities. Basic information on soil temperature and heat transfer

CRAMPED CONDITIONS at SRC's main laboratory necessitate the use of field trailers as office space during winter. Part of the SRC trailer fleet is shown on the Council parking lot.



NEW INDUSTRIES, such as this garment manufacturing plant at Zenon Park, are offered general management assistance by SRC's technical information service.

rates is being acquired by SRC. These data are required to develop economic designs.

High technology services, vital to the implementation of SRC's in-house work program, are available to other users on a fee-for-service basis. The Council's electronics facilities were contracted by the Saskatchewan Power Corporation to build sophisticated analog models of the company's electrical distribution system. The precision machine shop produced specialized rotary burner ovens required for uranium ore analysis by Saskatchewan-based mines. Remote sensing is becoming a progressively more important tool in many investigations. Council staff provided province-wide co-ordination between investigators and the Canada Centre for Remote Sensing aircraft facility. Chemical analyses were performed on more than 2,000 water samples, some involving determinations in the parts per billion range. New equipment was added to the analytical facility, including instruments to determine biological oxidation demand, trace element concentrations by fluorescence techniques, and low level radioactivity by alpha and beta spectrometry.

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PROGRAM OF THE COUNCIL'S STAFF

REPORT OF THE CHEMISTRY DIVISION

Brad H. Gunn

INTRODUCTION

The Chemistry Division's program is presently involved in little pure chemistry since the more pressing problems involve developing known technology and applying it in Saskatchewan.

Craft leathers, resembling smoke tanned-Indian leather are being made available for local demands. This work falls into the larger category of using "appropriate technology". In concept this is a departure from a rather dominant philosophy that there is always economy in scaled-up production.

Separation of a leaf protein concentrate from a high-fiber stem fraction of alfalfa is an interesting beginning in utilization protein rich plants. Chemical treatment of the roughage portion as well as chemical treatment of straw for increased digestibility is an approach being developed to ease the feed costs for cattle production.

A number of aquatic base line environmental studies have been completed. Waste treatment, recycling of wastes and environmental assessments are becoming a larger part of the total program.

Industrial Minerals

From time to time there has been an interest in producing potassium chemicals particularly potassium sulphate and potassium carbonate from refinery potash (KCl). While a variety of approaches have been suggested and considerable information is available from the literature and from our own experimental programs, no industrial development has taken place in Saskatchewan up to this time. Some of the reluctance to venture into chemical processing naturally arises from the fact that the magnitude of this kind of entrepreneurship is new to Saskatchewan. The desirability of shifting from primary to secondary industry is recognized but so far there has been difficulty in inducing industry to undertake such ventures and they remain fearful of plunging into an operation of such magnitude as to be competitive with those in other countries — notably in the United States. Usually one of the major constraints arises from the difficulty of finding markets for by products.

Uncertainties about energy costs may have further discouraged the introduction of high energy consuming processes. This does not seem to be a legitimate excuse in Saskatchewan where there are adequate supplies of lignite since lignite is probably the cheapest known source of energy at the present time. The excuse however, lies in the fact that using lignite or a processed lignite (other than for electricity) has not become normal practice. This suggests that a low calorific gas from lignite for industrial purposes would be a useful adjunct to industrial development in Saskatchewan.

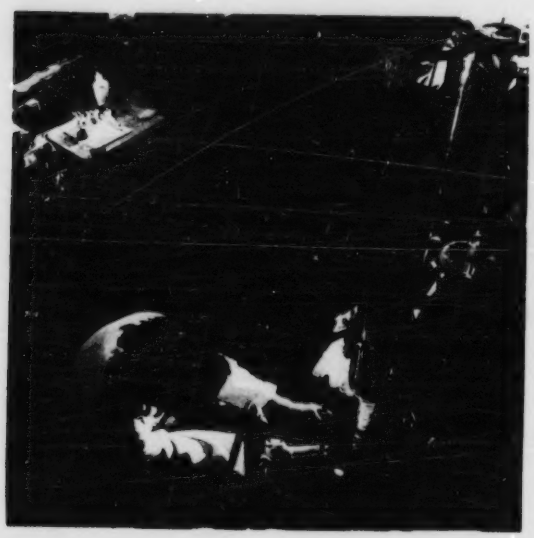
Food and Implications for Feedlots and Farm Practice

In past years, there have been incentives to diversify agriculture. By examining the history of raising cattle and hogs in Saskatchewan it is evident that periods of prosperity in the livestock industry were usually followed by reverses. Most of these reverses were the result of arid years and resultant low forage yields. As insurance against periods of low forage yields, a special effort was made at the SRC to learn more about drought resistant crops, both those native to Saskatchewan and those grown successfully in other arid regions of the world. Since protein is a major concern, both for animal nutrition and for human consumption, plants combining drought resistance and protein quality and quantity were sought. Kochia, garden atriplex and even Russian Thistle showed appreciable merit on the basis of these criteria. Certain followup work on testing various seeds and on contacting scientists actively involved in studies in other countries is continuing.

While it had been recognized that a drought might jeopardize the cattle and hog industries, the high cost of feed grain in a period of normal or

nearly normal production was not anticipated. The truth of the matter appears to lie in the fact there is now competition for food between man and beast and since the conversion of grain protein to beef protein is relatively poor (28:1), grain is suddenly too expensive to feed cattle. The cattle industry in particular is suffering severe stress. A greater use of roughage appears to be indicated. Straw is a relatively abundant roughage but without treatment has a very low digestibility. There are numerous claims that the digestibility of straw can be improved significantly by treating it with two to five per cent sodium hydroxide, ammonium hydroxide or calcium hydroxide. There is considerable urgency that something should be done immediately. The suggested steps are: (1) the development of simple economical techniques and equipment for treating straw on the farm or at the feed lot, (2) large scale cattle feeding trial to test the effectiveness and safeness of feeding processed straw, (3) the development of treating feeding systems which are ecologically and socially acceptable.

Of the crops successfully grown in Saskatchewan with a high protein content, alfalfa has a high rating, but so also have the leaves of grasses and cereals if harvested in an early stage of development. At this time some work has been done on concentrating protein from alfalfa by separating leaves from stems. The object is to separate a high protein low fiber leaf fraction from a lower protein high fiber straw fraction. The leaf fraction is to be tested as a protein supplement for various farm animals. Further processing of the leaf fraction would be aimed at producing products for direct human consumption. The stem fraction after further treatment would be tested as a high energy source for ruminants. Much of the experimental work has already been done elsewhere and the present effort at the SRC is directed toward devising practical processes to accommodate Saskatchewan situations. An economic analysis indicates that such a process should be feasible provided the products can be made adequately digestible. The temperature of drying alfalfa may influence digestibility, it may also affect the availability of protein.



PROTEIN DIGESTIBILITY OF STRAW for ruminants can be increased by adding controlled amounts of gaseous ammonia to straw. By using straw normally discarded as waste, this study's objective is to offset high feed grain prices in Saskatchewan.

Through the co-operation of the Northeast Alfalfa Dehydrators Research Association and the Melfort station of Agriculture Canada, large samples were obtained: (1) of hot air dried alfalfa and (2) of field cut low temperature air dried alfalfa. The particle size of the latter was reduced so as to make it comparable with those obtained from the former. Both samples were then transported by truck to Denver, Colorado where they were separated into two fractions by air classification in pilot scale equipment. Good separation into leaf and stem fractions were obtained for both samples. At the present time stem fractions are being treated with small quantities of sodium hydroxide and ammonium hydroxide for the purpose of assessing improvements in rumen digestibility.

The studies on straw and alfalfa involve active collaboration and consultation with the animal science department of the University of Saskatchewan, the Western College of Veterinary Medicine, Agriculture Canada and with several feedlot operators.

Leather Tanning

The chemical aspect of the Indian leather tanning process appears to be nearing completion. It may be recalled that the object of the exercise was to produce a leather similar to Indian smoke tanned leather particularly with respect to feel, appearance and ease of sewing and furthermore to do so by processes much less laborious and time consuming than those traditionally used. There were also some further constrictions. The process should be simple; the equipment unelaborate and inexpensive, the tannery should be small by conventional standards, and the process should present minimal pollution.

After a series of experiments at the Council and some development work at a small experimental tannery in Alberta, the project was discussed with a researcher in a commercial tannery. With his broad

experience and our experimental results, he was able to devise a commercial process which appears to meet most of the general requirements. Arrangements are now being made for large scale tanning trials, provided there is an adequate supply of deerskin available. The leather from the deerskin will be distributed for evaluation by various interested handicraft groups and by manufacturers of leather items in Western Canada. If the evaluations are favourable, the way may be paved for a small scale commercial production of the kind of leather which for a long time has been in demand in Western Canada. In this event there would be job creation both in tanning and in the crafts based on leather.

A second project on hides is under contract. The broad objectives are to produce food, feed and leather from hides by processes which cause lower pollution problems than conventional tanneries.

Environment

The demands on our small environmental group have continued to increase in 1974. A two year contract with the Saskatchewan Department of Tourism and Renewable Resources for studies on the Churchill River system has been completed. Overlapping this project was a contract with the Saskatchewan Department of the Environment for work on Tobin Lake and another contract for an environmental baseline survey of the Cluff Lake area as a requirement to precede the uranium mine development of Amok Ltd.

In view of increasing activities in hydroelectric, industrial, mining and waste recycling developments, the Saskatchewan Research Council is preparing itself for broader areas of environmental assessment. Our staff has recently been augmented by a terrestrial ecologist with a background in agricultural research involving soil quality and invertebrate biology. Certainly capabilities of such a person will complement those of our aquatic biologist in dealing with problems of water quality and land use management as they relate to various mining, industrial and agricultural developments in Saskatchewan.

Waste and Effluent Treatment

With more stringent regulations about sewage and the consequent penalties being levied by municipal authorities, there is an increasing demand for ways of cleaning up industrial wastes. Reverse osmosis apparatus has been successfully used at the SRC to remove dissolved solids from industrial sewage. Reverse osmosis is capable of cleaning up industrial sewage so that it can be returned to the plant for reuse. It can also in some instances concentrate valuable components. As a method of treating sewage, reverse osmosis can be recommended on the basis of energy costs, ease of operation, and for small space requirements. Its weakness is that it may, in many cases, not concentrate the contaminant sufficiently for easy recovery. Actually, reverse osmosis is still in an early stage of development and improved membranes with greater specificity are being produced. As a technique for separating constituents in effluent it has a high potential and a promising future. A test program has been performed under contract and SRC is looking forward to continued use of reverse osmosis as a method of treating industrial effluent.

Peat Moss

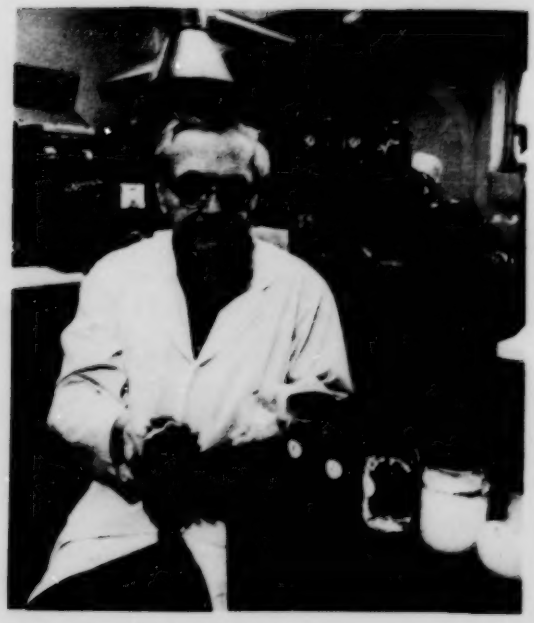
A successful method of pelletizing peat moss was developed last year and the pelletized material was used in field and in greenhouse pot trials. This year larger quantities of peat pellets were prepared for experimental use. While it was thought that there might be an enhancement in activity of chemicals in the pellets if pelletizing was performed at higher temperatures and pressures such as would occur if 1/8 inch diameter pellets were prepared, difficulties in pelletizing made it necessary to resort to pelletizing at 1/4 inch diameter.

Again this year, field plot trials were conducted in co-operation with the College of Agriculture, University of Saskatchewan. The purpose of the trials was to compare the effects in growth of peat pellets, commercial peat moss and untreated soil. For the assessment two crops were grown, a root crop (carrots) and a leaf crop (kale). The experiments with carrots failed because of poor germination. The results of the trial with kale are being evaluated.

Quite a different use for peat moss has arisen from some recent experiments. From these it has been found that peat moss pellets can be carbonized to a high grade activated carbon nearly comparable in shape, size and strength to the original pellet. The ash content of activated carbon from peat is low. Its purity may be such that it can find a ready market in the food industry. Naturally, it has every chance of being useful in the rapidly expanding market for activated carbon in the tertiary treatment of sewage.

Service Functions

Carbon 14 Dating. While four counters flicker monotonously day in and day out with only slight interruptions for the introduction of new samples, it is quite easy to overlook the exciting consequences of the routine experimental work. Not so, for people who have worked diligently and meticulously to collect something from the past and learn where it



PROTEIN EXTRACTS from hair are a promising new additive to livestock feed. Hair protein material, presently an abattoir waste product, has been isolated by Ernst Mueller: the sequence of products, from new hair to purified extract, appears in the foreground left to right.

fits into history. One of the 160 samples dated last year set the records straight about certain ancient Nicaraguan footprints. Accordingly it has been reported in the Archaelogy Journal that the footprints as determined by carbon dating at the Saskatchewan lab were made around 3,000 B.C. a period of time when the civilization was already domesticating beans, corn, and squash. This contrasts sharply with earlier conjectures that the footprints were possibly as much as 200,00 years old.

Analytical Services

Water accounted for the greatest portion of the work load in the analytical laboratory. Two thousand water samples were analyzed for major constituents in the past year. Trace elements, frequently in the sub-microgram range, were often required. Water analyses were performed for environmental baseline studies, pollution monitoring, water quality studies and water purification experiments. The recent thrust toward improved analytical results with respect to accuracy, sensitivity, and speed of execution has necessitated a constant review and updating of analytical procedures as well as the acquisition of new apparatus. An automated spectrophotometer analyzer and a Dow-type carbon analyzer were assembled in our lab from selected components at a much lower cost than equivalent commercial units and have proven extremely useful in taking care of a heavy work load.

The determination of biological oxygen demand has been brought up to date by changing from the titration method to the dissolved oxygen probe method. Several methods of determining trace metals in aqueous and solid samples by using a high temperature graphite furnace in conjunction with an atomic spectrometer were investigated. In the parts per billion range the chelation-extraction method is still superior for quantitative determinations of the transition metals in water samples.

ENVIRONMENTAL RADIOACTIVITY is monitored with SRC facilities. Here Gene Smithson is examining emissions from radioactive isotopes of radium, polonium and lead. Environmental levels of these elements can be frequently assessed in areas near Saskatchewan uranium mines.

A backlog of coal analysis from last year's drilling program was completed this past summer. An additional 40 to 50 coal samples received this year have also been analyzed. A normal number of samples of potash, sodium sulphate, carnallite, and fatty acid amines were analyzed during the year. There has been an increasing number of special requests for trace contaminants in relatively standard products. A variety of non-routine analyses were performed on a wide range of samples from agencies within and outside the province.

Instrumentation for determining low levels of

radioactivity in the environment has been acquired during the summer. The main purpose of this facility will be to determine uranium and its decay products by alpha and beta spectrometry. The highly sophisticated nature of the radiation measuring equipment will make it possible to expand the scope of the facility so as to encompass all types of radioactive measurements. In addition, this equipment includes the basic analyzing system for non-dispersive x-ray fluorescence analysis. The sensitivity of this technique is being improved rapidly and it may become the method of choice for the simultaneous determinations of a wide range of elements at trace levels in solid and liquid samples.

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REPORT OF THE ENGINEERING DIVISION

W. H. W. Husband, Head

INTRODUCTION

The ceramics laboratory completed another active year working on industrial contracts and with the Department of Industry and Commerce. A drilling program was undertaken during the summer to evaluate several specific deposits of clay.

Efforts are being increased to recover magnesium sulphate from alkaline lakes in Saskatchewan. Hydrological studies have reached the stage where sufficient field information is available to begin preliminary evaluation of recovery methods.

The Department of Northern Saskatchewan has authorized a study to determine the proper methods of installing water lines in northern communities.

A study to evaluate the use of waste flyash from electrical generating plants to remove algae and other nutrients from water supplies and lakes has been completed. Preliminary organization has begun on a programme to determine the extent of agriculture's part in pollution of the Qu'Appelle River system.

Large-scale demonstrations of the spray freezing method of desalinizing Saskatchewan groundwaters were continued at four sites with good results.

A programme for the federal Ministry of Transport on transportation of solids in pipelines has continued with emphasis now on sending coal through oil pipelines.

The hydrology group is developing methods of predicting evaporation from reservoirs and spring runoff flows in small streams. A tentative method of predicting runoff quantities which was developed from small stream information can predict flows in much larger streams.

Uses for Saskatchewan Clays

Saskatchewan has large reserves of a wide variety of clays which could be used to make any of the products commonly made from clay: common brick, facing brick, refractories, structural tile, partition tile, floor tile, wall tile, drain tile, sewer pipe, flue lining, pottery, binders for ores and fillers for paint and rubber products. At present, Estevan Brick produces common and face brick, Westclay in Regina produces flue lining and sewer pipe and A. P. Green at Claybank produces refractory brick. Large quantities of clay products are imported and those which are made in Canada use considerable amounts of imported clays. As an example, only 30 per cent of the floor and wall tile used in Canada (a market of more than $50 million per year) is made in Canada and all of this uses imported clays as raw material.

WHITE BRICK from Saskatchewan clay is an item in high demand by the U.S. market. John Hudson is shown evaluating a brick sample. Ceramics facilities at SRC provide service to the Saskatchewan clay industries.

A ceramics laboratory has been maintained by the Division for many years in order to provide technical assistance and laboratory facilities for the various companies engaged in manufacturing clay products. Such companies normally are not large

enough to do their own research and development. While providing these services, the division's staff has developed a sound background concerning the Province's clay resources and has determined the areas for potential development.

During the past year, the laboratory worked on contract research for various companies and for the Saskatchewan Department of Industry and Commerce. In addition, beneficiation of Saskatchewan kaolin by selective flocculation and production of floor cleaners and cat litters from clays were studied. Although a satisfactory product was developed in the latter case, similar studies showed that a superior product could be made from low grade diatomite deposits found elsewhere in Canada and so this particular project was terminated.

Development of Natural Resources

There are about 25 million tons of magnesium sulphate in the alkaline lakes of Saskatchewan. This chemical can be used in place of sodium sulphate for making wood pulp. It has an advantage in that its use makes pollution control an easier and less costly operation. Up to now, the pulp industry has not considered using magnesium sulphate because no one had made a serious effort to develop a commercial supply in North America.

In 1966 the division began a study of the water and salt balances of Big Quill Lake, which contains 10 million tons of magnesium sulphate in solution. The objectives were to determine the origins of the water and salt and then to develop a recovery process. By 1976 there will be sufficient information to determine the economics of various potential recovery processes. Several such processes currently are being investigated under contract.

There are approximately 20 million tons of marl, a soft earthy form of limestone, at Sturgeon Lake which is 25 miles north-west of Prince Albert. Limestone and lime made from limestone are used in pulp mills, steel mills, water treatment plants, cement plants, the construction industry, and in highway construction. At present there is no production of limestone or lime in Saskatchewan and so the equivalent of 280,000 tons per year of limestone are imported from Alberta and Manitoba.

The deposit in Sturgeon Lake contains about 60 per cent marl which is mixed with sand and mud. The marl was formed thousands of years ago as a secretion by algae and thus has organic matter throughout which, along with the sand and mud, has prevented economic recovery. In 1973-1974 a thorough study was made of the beneficiation of the marl deposit and a recovery process was developed under contract with the Saskatchewan Department of Industry and Commerce and Saskatchewan Minerals. The resulting process can produce a product containing less than 2.5 per cent impurities which is suitable for most uses.

Vast quantities of various salts such as, salt, potash, and carnallite exist under Saskatchewan. At present, potash and common salt are being recovered. Both are being recovered in part by solution mining, a method which does not require extensive mines, but pumps water down bore holes to dissolve the ore and force the resulting brine back to the surface. The same method could be used to recover carnallite which contains magnesium. Production of magnesia, a compound of magnesium, for use in refractory brick or in insulation has been given consideration in Canada.

During the current year the division is completing its studies of the theory of solution mining. It is developing a method of calculating the performance of solution mining which can be used in economic feasibility studies of alternate ways of expanding potash production and recovering carnallite. The work is being carried out under a research agreement contract with the federal Department of Energy, Mines and Resources.

Improvement in Construction Methods

The Department of Northern Saskatchewan has assumed responsibility for design, construction, operation and maintenance of all sewer and water facilities in Northern Saskatchewan. Currently it is engaged in a long term program to bring water and sewage facilities to fifteen communities and has encountered inadequacies in standard construction practices. Present construction techniques can be described as either conventional or permafrost types. However, the Department now has to work in a third area, a "grey area" in which conventional techniques are inadequate while permafrost techniques are unnecessarily complicated and costly.

In the "grey area" it is difficult to select a suitable design compromise, mainly because design data are non-existent. Consequently, the division has been requested to study ground temperatures and their effects on the utility piping systems. Four typical townsites have been selected and the ground temperature profile and the performance of the utility piping systems are being studied over a four-year period. Instrumentation was installed at La Loche, Weyakwin, and Cumberland House during the past summer's construction season and similar action will be taken at Buffalo Narrows in

1975. The main objects of the program are to determine the safest and most economical depths for utility piping systems, the various climatic and topographic regimes and to indicate the advantages and disadvantages of various designs of the utility connections.

During the design of the Idylwyld underpass in Saskatoon, the consulting engineers found that, for highway construction purposes, there were no suitable or reliable data for Saskatchewan on storm intensities of various durations and return periods. Consequently, the solution was to over-design. The division undertook to instrument the 17 acres of drainage area involved and to record the rainfall-runoff patterns for 10 years in order to provide basic information for economic construction of storm sewer systems in built-up areas. During summer storms, data from rain gauges, flow meters, and a water level indicator are collected by a computer and stored for future examination. Four years of data have been collected and preliminary examination is about to be undertaken.

Protection of the Environment

In Saskatchewan, as well as in other more populated areas of Canada, changes in population and development patterns have been accompanied by more intensive and sometimes conflicting uses of water and land. The demand for water and land for agricultural, urban and recreational uses has created problems of deteriorating water quality, algae in lakes and streams, greater damage through floods and reduced wildlife habitats. Several projects relating to protection of the environment were continued by the division during 1974 and additional work related to the Qu'Appelle Valley is being undertaken. A study of ways to dispose of brines produced by desalination of domestic or municipal water supplies has continued and the technology of disposing sewage effluent through irrigation continues to be reviewed. A study of the use of waste flyash from electrical generating stations to remove deleterious nutrients or improve water and sewage treatment was completed and a new project has been initiated to examine the possibilities of feedlots polluting surface waters.

The program to improve adequate water supplies from saline and brackish groundwaters has incorporated in it a study of disposing waste brines by discharge to alkaline sloughs, controlled dilution in streams, and solar evaporation. At least one of these methods will be possible at most locations in Saskatchewan where water supplies should be improved. The results obtained from the first two years of operation indicate all methods are feasible.

Experiments in 1972 at the University of Saskatchewan, Regina Campus, showed that flyash could be used to remove phosphorus and algae from water supplies and waste effluents. As the Saskatchewan Power Corporation has to dispose of more than 300,000 tons per year of waste flyash, the division was requested to extend this work to evaluate Boundary Dam flyash on a larger scale. Consequently, both laboratory and bench scale tests were undertaken on the use of Boundary Dam flyash to remove algae from a sewage lagoon and from Blackstrap, Pasqua, and Echo Lakes. Additional tests were made to remove phosphates from Saskatoon's sewage plant effluent and to assist coagulation of suspended solids in normal treatment of urban water supplies from the South Saskatchewan River. Encouraging results were obtained for algae removal: 80 per cent of the algae in samples from Pasqua Lake could be removed. However, the flyash was very ineffective in removing phosphates and was of no use in raw water treatment.

The principal water quality problems in the Qu'Appelle River System are the highly eutrophic conditions of the lakes and the low dissolved oxygen levels in some parts of the system. These problems are related directly to the amount and nature of the wastes which are discharged into the system by cities such as Regina and Moose Jaw. Agriculture also has been considered as a significant source of pollutants. Prolific growths of algae and aquatic plants in the lakes are supported by the abundance of nutrients available in the system. Phosphorus is critical to algae growth and is the most easily controlled. If the present rate of deterioration of the system is to be retarded, a reduction in the rate of phosphorus entering it is required. Single sources of nutrients, such as cities, are not difficult to evaluate and proper controls can be designed. On the other hand, evaluation of sources of nutrients from agriculture is much more difficult as there are many potential small sources and no data. With the assistance of the Departments of Agriculture and Environment, the division is developing a program to provide the data required. Ten feedlots of various size and distances from water courses have been chosen in the Qu'Appelle basin for water quality and surface runoff investigations. The runoff from these feedlots could enter Pheasant Creek which in turn runs into the Qu'Appelle River. The basic plan consists of sampling runoff streams, estimating runoff volumes, calculating the quantities of nutrients in each stream and determining the sources of the nutrients. The The program is being conducted in co-operation with the Family Farm Improvement Branch of the Department of Agriculture.

Good Drinking Water

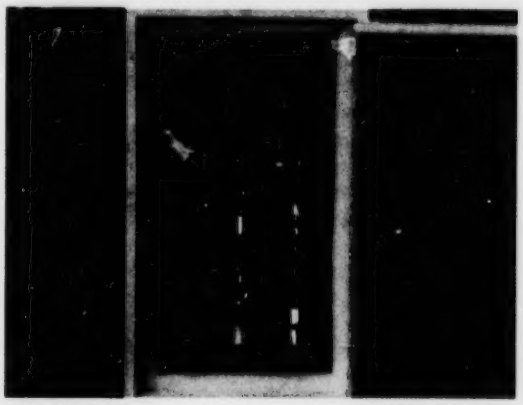
In much of the settled area of Saskatchewan, brackish groundwater is the only reliable, locally available water supply. Because the population density is low, a potable water distribution system would be very expensive. Consequently, many people are using water with a salt content exceeding the recommended provincial standard of 600 parts per million. This water often tastes bad, and is not good for stock watering, washing, or watering gardens and lawns. Also, household appliances and personal items are subject to physical damage from chemicals in the water, resulting in higher costs. To indicate the magnitude of these costs, it has been estimated that total household damage in Montana from using poor quality water exceeds 200 million dollars per year.

Desalination of brackish water is now considered to be a reliable method of supplying potable water. The major emphasis in research and development has been toward automated plants of large capacity, hence small capacity units such as would be needed in Saskatchewan would have relatively high operating costs because of complex processing equipment.

SPRING RUNOFF can be measured with an SRC developed fluorometric method. Larry Hesterman is shown setting up dye injector equipment near Maidstone. Dye injected upstream is continuously collected downstream and tested for fluorescence. This method is more flexible and less expensive than the previously used methods. Among data users are PFRA and Environment Saskatchewan who employ the information for designing dugouts and water quality studies.

concentrated brine surrounding almost pure crystals of ice. During the winter some of the brine drains to the bottom and much of the remainder is flushed from the ice by the first meltwater in the spring. The brine is discarded and the rest of the ice is melted and stored for use.

Layer freezing is a somewhat more complex process in which a block of ice 12 to 15 feet thick is built up during the winter by flooding successive layers of brackish water on top of previously frozen ice. If the water addition rates are adjusted properly, the ice block can be maintained just below the freezing temperature. Under this condition, most of the salts will remain dissolved in

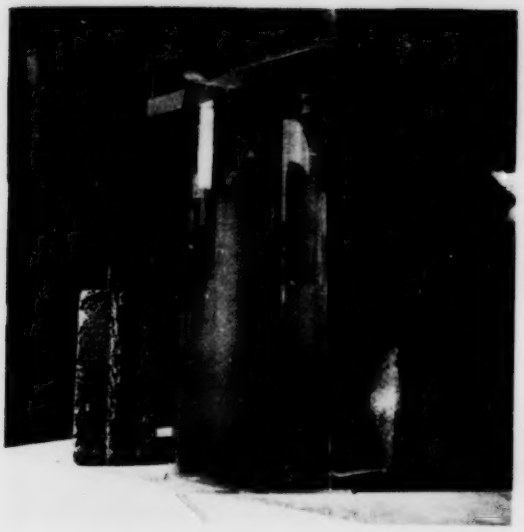


AUTOMATIC DYE SAMPLERS must run unattended in rigorous spring conditions. This SRC developed unit collects a water sample every 37-1/2 minutes. Dye concentrations are analysed in a mobile laboratory permitting rapid computation of water flow rates.

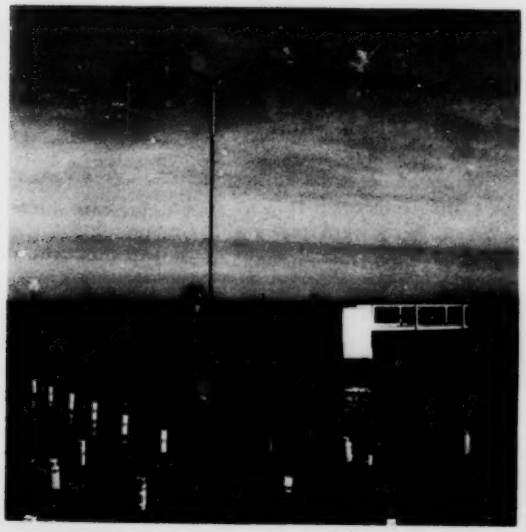
To meet the needs of farmers and residents in small communities in Saskatchewan the division has been investigating novel desalination methods which use the unlimited natural refrigeration available during a normal Saskatchewan winter to remove the salts from brackish groundwater by natural freezing. Three methods have been studied; reservoir freezing, layer freezing and spray freezing.

Reservoir freezing is a simple process in which brackish water is frozen naturally in a shallow reservoir over the winter. The ice which forms will have a lower salt content than the original brackish water; the salts concentrate in the brine beneath the ice. The brine is pumped away in the spring and the ice melt is stored for use during the year. Experiments were conducted for six years in lined and unlined reservoirs using a natural brackish groundwater. Yields of about 17 gallons per square foot of ice surface were obtained and in all tests the product water contained less than one-quarter as much salt as the original brackish water.

Spray freezing is similar to layer freezing except that the brackish water is sprayed continously onto a gently sloping land area to build up a mound of ice which can reach a height of 50 feet over a win-



POTASH MINING by solution methods can be investigated by theoretical means and simulated with a model. The center plate is water-soluble, simulating a potash body. Dye included in the plate appears in layers in the tank, illustrating patterns of concentration distribution found in a full scale mine.



SPRAY FREEZING of saline water furnishes a method of using free winter refrigeration to separate pure water from brackish water. Mike Barker is checking the water pattern from a spray head at an SRC test site.

ter. The ice mound is self-supporting so no retaining walls or earthwork are required. As with layer freezing, most of the salts are in the initial drainage which is discarded. The remaining ice is melted to produce fresh water. Spray freezing appears to be the simplest and least expensive water desalination method for use in Saskatchewan.

During the 1973-1974 winter there were nine spray freezing trials. These were; one at Saskatoon using water containing 3300 parts per million (ppm) sodium chloride; two near the village of Blucher using groundwater containing 3300 ppm salts, primarily sodium sulphate; two near the town of Bruno using groundwater containing 2450 ppm salts, mainly sodium sulphate, chloride and bicarbonate; two on a farm near Armley (north of Tisdale) using groundwater containing 4100 ppm salts, mainly sodium chloride, sulphate and bicarbonate; and two near the village of Frontier using groundwater containing 1800 ppm salts, primarily sodium bicarbonate with some sodium chloride. One unit at each location was lined with a butyl rubber membrane so that the melt water could be measured accurately.

SALT RECOVERY by natural freezing is studied by Walt Spyker using this convenient model located in a cold room. Work by SRC at Quill Lake indicates it contains 20,000,000 tons of magnesium sulphate and sodium sulphate mixed in the brine. Low-cost recovery of these salts by freezing could make their development economic.

These trials gave the division an opportunity to investigate spray freezing of the various types of brackish groundwaters found in Saskatchewan over a range of climatic conditions. Because of

these differences, the quantity and quality of the recovered water varied from site to site. At Armley over 1,000,000 gallons were sprayed into each unit while at Frontier where the only major difference was the climate, only 350,000 gallons were sprayed into each unit. The quality of the water recovered at Frontier was excellent however. The results also show that the process works best for water containing primarily chloride or bicarbonate, but satisfactory results were obtained for waters containing sulphates. At eight of the nine sites over 70 percent of the input was recovered as water containing less than 1500 ppm dissolved salts, the tolerance limit established by Environment Saskatchewan.

During 1974-1975 tests are being repeated at all sites to investigate the effects which weather variations have on the results, and a new type of spray head is being used. In addition, a larger spray area with five spray heads has been constructed at the Frontier site. This will provide information on interactions between spray heads which might occur in a full scale operation. Also, an infiltration pond has been constructed near the village's shallow wells. The product water will be pumped into this pond in an attempt to recharge the shallow aquifer. If this is successful, it will provide a reliable means of maintaining water levels in shallow aquifers which are often of limited capacity and can go dry in periods of low natural recharge.

Pipelines for Energy Transportation

Industry and government have been considering the possibility of transporting coal from Western Canada to Ontario via a coal-in-oil pipeline for use in thermal power plants and production of coke for the metallurgical industry. The experience obtained by the division since 1960 on the development of solids pipelines indicated that experimental data from large scale tests are required to assess properly the technical aspects, the economics of potential projects, and to give industrial executives confidence when new combinations of liquids and solids are involved.

In 1971 Canada imported 18 million tons of coal from the United States and almost 10 million tons of this coal were used for thermal power generation in Ontario. At the same time more than 1 million barrels per day of oil were used in Eastern Canada. The Department of the Interior in the United States has become concerned about the "energy crisis" in that country and has organized large and costly development programs to ensure its coal reserves will be utilized to fill the energy gap forecast before nuclear power takes over around the year 2000. Large quantities of Western coal will be transported to mid-west states where it will be used for thermal power generation. Eastern coal will be in demand for the same use in eastern and north-eastern states. Undoubtedly the cost of energy from coal will increase substantially during this period and the United States coal will not be so readily available for export to Canada.

Limited experimental work on the concept of transporting coal-in-oil has been done by the Research Council of Alberta in the late 1950's and recently by the Saskatchewan Research Council and the Department of Energy, Mines and Resources. The latter's work was concerned with the combustion of an oil-coal slurry in conventional burners. Tests using bituminous and lignite coals clearly indicated that combustion of coal-in-oil fuel is feasible. Calculations by that Department show that adding 1.1 billion tons of coal to present proven Canadian oil reserves would extend the reserves by 7 years at the 1970 rate of oil consumption. Adding the total recoverable 4.5 billion tons of high rank western coal to assumed recoverable oil would extend the oil resources by 30 years. When one considers that there are at least 14 billion tons of lignite coal in Saskatchewan alone, the long-term potential for conserving Canadian oil resources is apparent.

As no long distance coal-in-oil pipelines are presently in operation, and as the necessary technology has not been developed, it was deemed important to generate sufficient information to permit consulting engineers to properly design long-distance coal-in-oil pipelines. Consequently, the Transportation Development Agency of the Federal Ministry of Transport awarded an 18 month contract to the division in October of 1973 to investigate the pipeline transportation of western Canadian thermal and metallurgical coals in crude oil. The division is more than half-way through a programme to: 1. determine the desirable characteristics of the delivered coal or coal-in-oil slurry at thermal power plants and the desirable characteristics of the separated oil to be delivered to oil refineries in Eastern Canada: 2. determine the properties and characteristics of the coals and oils considered for pipelining, assess the relative value of changes in these properties as a result of long-term slurrying, and to develop methods for upgrading before, after or while the commodities are in transport; and 3. delineate all technical problems associated with the transport process itself and develop pipeline slurry technology at the 2" diameter pipeline level in preparation for future large scale test work.

Water Supplies

Water is a basic resource. An adequate supply of good quality water is necessary for continued agricultural and industrial growth. Most of the province's water supply comes from snowmelt runoff. This runoff originates in small drainage basins and eventually reaches the major river systems. Knowledge of the hydrology of these small basins is required to predict flood potentials and the quality and quantity of water which can be expected under different climatic conditions.

The study of small drainage basins and the water balance of sloughs was designed to provide needed information on the hydrology of Saskatchewan. Hydrometeorological data from selected sloughs have been collected from various parts of the province to include different meteorologic and soil conditions. The results of the study will be used to indicate whether sloughs can be used to recharge the groundwater and to determine the effect of agricultural drainage on the local groundwater levels. Using the data collected so far, the permanency of sloughs can be determined as a function of meteorological factors. This can be used further in the selection of sloughs for supplying water for irrigation, waterfowl habitat and for agricultural reclamation. A method to compute evaporation from open water surfaces has been developed and has been successfully applied to lakes and reservoirs in Saskatchewan.

The Council operates five small drainage basins, two in the Delisle area, one in the Floral area, and two in the Wilkie area. These are agricultural watersheds varying in size from about 140 acres to about 1,000 acres. A watershed model has been developed from the data collected from these basins and tentative methods have been proposed to predict peak and total flow from agricultural watersheds. The model has been shown to be equally valid for large drainage basins in the province up to several thousand square miles in area. An essential feature of this model is its applicability to Saskatchewan's conditions in both geomorphic and meteorologic aspects. The study is being continued to improve the model to include such factors as depression storage in sloughs and dugouts, land use and groundwater consumption.

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Hudson, J. H.; Warren, T. E. *Feasibility of a Clay Products Complex in Saskatchewan*. E 74-2.

Lakshman, G. *Drainage Basin Study*. Progress Report No. 9. E 74-8.

Spyker, J. W. *Natural Freeze Desalination of Brackish Water*. Progress Report 1972-73. E 74-1.

Thauberger, J. C.; Smith, L. J. *Erosion Studies of Polymeric Pipelining Materials*. Report 2. E 74-6 (confidential).

Whiting, J. *Evaluation and Interpretation of ERTS Imagery for Big Quill Lake*, Report No. 3. E 74-3.

Whiting, J. *Closed Drainage Lakes are a Climatic Change Indicator*. E 74-10.

REPORT OF THE GEOLOGY DIVISION

R. G. Arnold, Head

INTRODUCTION

The application of geologic knowledge and expertise to provincial development and the solution of problems in the physical environment continued at an accelerated rate. It is becoming increasingly clear that geology can provide an important input into various elements of provincial development. The division was actively involved in ground water evaluation, physical environment studies in parks, coal inventory assessments, glacial geology, and geochemical studies in northern areas. Studies in northern areas were expanded and will continue to be emphasized in subsequent years because of government interest in northern development.

Groundwater Geology and Aquifer Evaluation

The mapping of glacial sediments, which cover most of the plains region of the province, was completed by E. A. Christiansen. A minor amount of test drilling was carried out to provide supplementary subsurface information. The results are summarized in a series of Geology and Groundwater Resource maps, 18 of which have been published to date (see Fig. 1). The remaining maps of the series will be published in 1975.

The test drilling phase of the program has resulted in the discovery of some interesting geological structures. At Fife Lake, near Unity, and at Esterhazy, the normal sequence of beds is disturbed by glacial thrusting which has resulted in aquifers being repeated (vertical stacking) or entirely missing. Test drilling in the Saskatoon and Regina areas has confirmed and extended the occurrence of collapse structures which probably form by the collapse of strata into underlying solution cavities developed in the Prairie Evaporite formation. The development of these structures has resulted in hundreds of feet of vertical displacement of the strata. The existence of these structures may have implications for groundwater circulation patterns and ground stability and should be investigated more thoroughly.

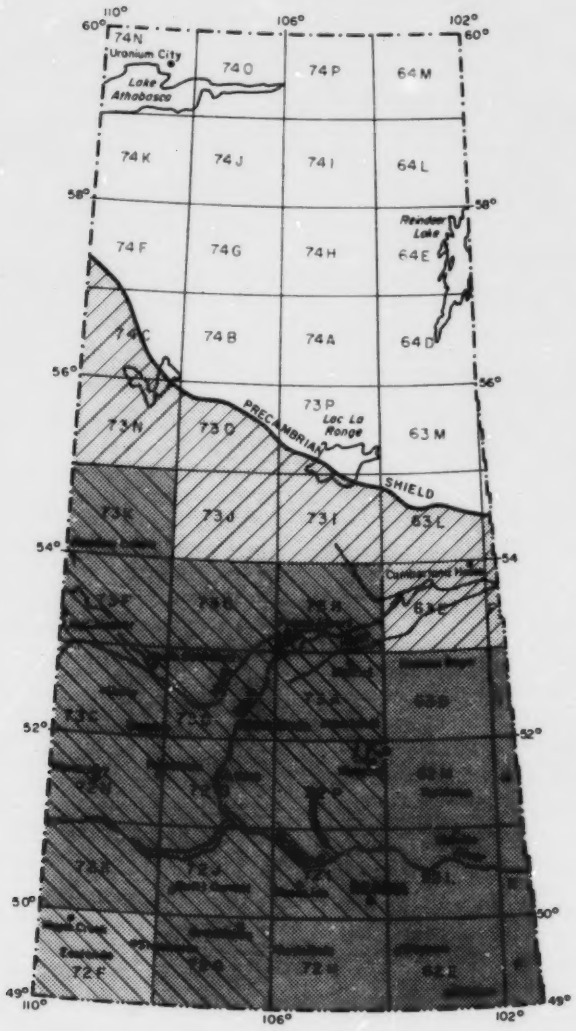
The geology of Meadow Lake Provincial Park and adjacent areas was studied and completed at the request of the Department of Tourism and Renewable Resources. The investigation involved some test drilling to obtain subsurface information. This information will be used for park development and for preparing a brochure for the interpretive program which will describe the glacial history of the area.

The groundwater hydrology program, under the supervision of W. A. Meneley, was very active during the year. The observation well network, designed to automatically record fluctuations in groundwater levels in the plains area, was expanded northward. The network provides basic data on groundwater behaviour that is required for groundwater management and the solution of hydrologic problems. A groundwater information service has been established to provide information about the availability and quality of groundwater for the plains region. A large contract commitment was undertaken during the year. This work included a study of an area near Moose Jaw to evaluate the suitability of the site for effluent irrigation, an aquifer evaluation at Yorkton, test drilling for a water supply at the fish hatchery on Echo Lake, and a number of smaller contracts.

Lignite Coal Evaluation

The joint federal-provincial lignite coal resource evaluation began in 1971 and reached the compilation stage in 1974. The compilation of field studies conducted by the Department of Mineral Resources (P. L. Broughton), the Geological Survey of Canada (J. A. Irvine) and the Saskatchewan Research Council (S. H. Whitaker) has produced the first realistic estimate of lignite reserves in Saskatchewan.

The lignite resources are defined as quantities of coal that can be feasibly extracted. Included within the resource estimates is that portion of the coal that would qualify as reserves and be mined at a profit at present market conditions. The resource estimates include all lignite seams at least five feet thick and within 150 feet of the land surface, and seams three to five feet thick provided the ratio of



Area covered by SRC Test Drilling Program

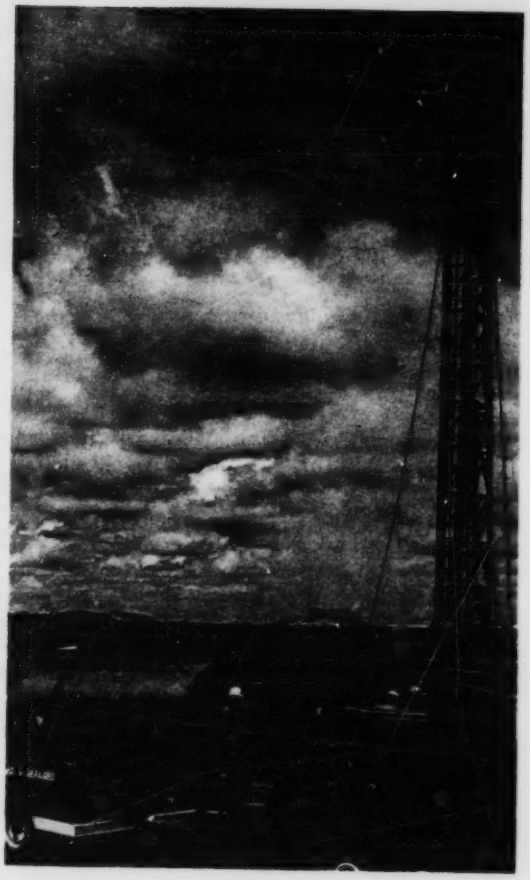
73 B National Topographic System Map Sheet Reference

Published in Geological map of Saskatchewan, 1972

Maps published

Maps to be published

Surficial deposits and aquifers mapped



LIGNITE RESOURCE evaluation, near Boundary Dam power plant (background) was part of a long-term SRC investigation of this energy source. Drilling rigs contracted and supervised by SRC collected coal cores for analysis at some 400 southern Saskatchewan sites.

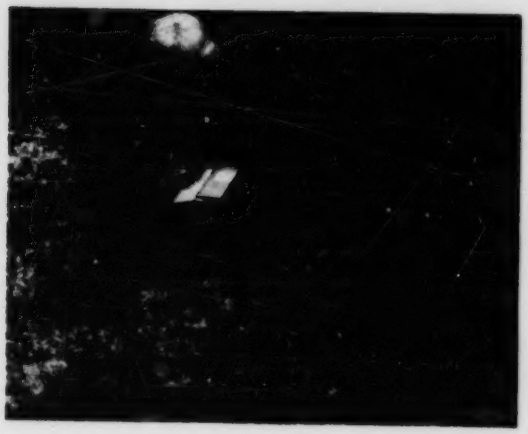
overburden to coal is equal to or less than 15. A specific gravity of 1.29 for lignite is used in all calculations. It is estimated that the total lignite coal resource of Saskatchewan is 5.67 billion short tons.

A four-month drilling and logging program was undertaken in the continuing evaluation of lignite permits and leases held by the Saskatchewan Power Corporation. The field studies, under the direction of J. R. McLean, completed one-quarter mile drilling control in 10 sections of the Fife Lake-Coronach area, one mile control in the Killdeer, Rockglen, and Bengough areas, and one mile plus one-half mile control in specific parts of the Estevan area. The program in the Fife Lake-Coronach area, begun in 1971 with the discovery of a major seam by S. H. Whitaker, culminated in the September announcement of a proposed generating station and strip mine near Coronach.

Geophysical logs were run in each testhole as in previous years. Major coal seams were sampled at two foot intervals, and selected samples were submitted to the chemistry division of the Council for analysis. Detailed mapping of seams and determination of lignite reserves are being undertaken at the present time.

Geochemical Prospecting Methods

Large areas of the north are covered by glacial overburden and are therefore difficult to prospect by the conventional method of examining outcrops. However, it is possible to obtain clues to the presence and location of ores on the bedrock surface by a thorough examination of the overlying overburden. This can be accomplished by conducting routine geochemical surveys in overburden areas together with studies of the provenance of overburden. This work is being done under the supervision of D. R. Haughton.



SOIL SAMPLES can provide clues to mineral distributions in the Precambrian shield area. Here Alvin Anderson takes, near George Lake, one of the 10,000 soil samples collected in SRC's 1974 geochemical field program. These samples are analysed for 10 elements and the results are computer-processed to assess possible exploration targets.

This year research on geochemical methods as applied to overburden was conducted on the George Lake property held by Falconbridge Nickel Mines Ltd., 180 miles northeast of La Ronge. The property contains an ore deposit of five million tons averaging 0.35 per cent lead and 2.65 per cent zinc in quartizite. The ore is exposed to the bedrock surface but is covered with approximately 100 feet of

overburden. The ore body was initially found by tracing mineralized boulders in overburden back to the source. The objective of the geochemical program was to devise a sampling scheme that would detect the ore body and indicate its location. In the course of this work, glacial overburden, bog deposits, lake sediments, lake bottom waters and vegetation were sampled, a biophysical terrain map was produced, and a naturally induced potential survey was conducted over a portion of the property. The study has resulted in a refinement of geochemical techniques and has led to the location of a second zone that may contain additional ore. This possibility is being followed up by Falconbridge. We wish to thank Falconbridge for their cooperation and permission to carry out this study.

Geochemical surveys were conducted over two areas on the "La Ronge Horseshoe" which is a biotite-gneiss formation with good copper potential. These surveys were conducted on properties approximately 36 miles north of La Ronge for the Department of Northern Saskatchewan's mineral evaluation program.

AUGER DRILLING techniques are employed by Earl Christiansen near Missinipe as part of an SRC investigation of surficial geology in a 6,000 square mile area near La Ronge.

Glacial Geology in the North

A new four year program of mapping glacial deposits in the north was initiated this year under contract with the Department of Mineral Resources as part of the federal-provincial DREE agreement. The program is being carried out by B. T. Schreiner and D. W. Alley under the general supervision of E. A. Christiansen. The geochemical component of the program is being supervised by D. R. Haughton. The objectives of the mapping program are to determine the types, distribution, properties, and history of emplacement of the glacial sediments. This information has multiple uses in exploration programs in glaciated terrain.

The mapping program was carried out in national topographic area 73P which includes the Town of La Ronge. Mapping was done from available roads, and from lakes using boats and aircraft. Approximately 15 holes were augered in overburden

ANCIENT VOLCANIC ROCKS host many of the economic base metal deposits in the Canadian Shield. Volcanic fragments such as those being sized by Joe Fox in the Amisk Lake area, provide clues to location of base metal deposits.

along roads with indicated overburden thicknessess of five to 75 feet. D. F. Acton of The Saskatchewan Institute of Pedology is co-operating with the study and will provide soil analyses for the principal sedimentary units identified. During the course of the mapping program, rock outcrops and lake sediments are sampled for geochemical purposes.

Base Metal Potential of Volcanic Rocks

J. S. Fox has initiated a program that will permit an assessment of the base metal potential of volcanic rocks in the province. Base metal deposits are preferentially associated with acid volcanic lithologies and the objective of the study is to develop field and chemical criteria for identifying the more favourable strata despite the effects of metamorphism that have erased many primary volcanic features. The detailed map to be published at the end of the project will incorporate structure and stratigraphy and will be of use in the delineation of exploration targets.

The field program was initiated on the west side of Amisk Lake approximately 25 miles southwest of Flin Flon. Mapping is at a scale of 1:15,840 and the work to date indicates that the geology is more complex than indicated by previous work. In addition to mapping, statistical work is being carried out on fragment-size distribution in pyroclastic units, and trace metal and major element analyses of selected pyroclastic material are being obtained.

Cartography and Drafting

The cartography and drafting unit under the supervision of W. E. Taylor, is responsible for the design, preparation and production of division publications and maps. It is also responsible for inventories of topographic and base maps, air photos, E-logs, and the preparation of air photo mosaics as well as the co-ordination of airborne remote sensing tasks for the province by the Canada Center for Remote Sensing.

Among many accomplishments this year, the cartography group completed the indexing of the complete LIFT air photo series for the province, completed four Geology and Groundwater Resource maps, two geochemical reports, several scientific papers and supplied base maps for all field programs. Interest in the air photo mosaic program increased during the year with two government departments acquiring complete collections of prints.

Two staff cartographers from the Saskatchewan Department of Mineral Resources spent 5 months with the Council's cartographic unit working on their own mapping projects on an "in-house"

SCRIBING TECHNIQUES, in which tiny cutting points are employed to make precise maps on stable plastic material, are employed at SRC. Here Brian McIntosh works on a new groundwater map of the Weyburn area.

training program. Assistance was also given to other government departments and agencies in the applications of modern cartographic techniques and the solution of cartographic problems.

W. E. Taylor, was appointed to a technical advisory committee for the Drafting and Survey Technology course at the Saskatchewan Technical Institute, Moose Jaw, and to a special committee studying the feasibility of instituting a cartography course in a technical institute in the province.

AIR PHOTO MOSAICS are a valuable tool in many types of environmental studies. Extensive photo handling at SRC permit in-house construction of mosaics. Doug Alley (left) and Bryan Schreiner discuss a layout with Bill Dear (right).

Reports and Publications

Christiansen, E. A. *Geology and Groundwater Resources of the Prince Albert Area (73 H), Saskatchewan:* SRC Map 15.

Christiansen, E. A. *Geology and Groundwater Resources of the Shellbrook Area (73 G), Saskatchewan:* SRC Map 17.

Christiansen, E. A. *Geology and Groundwater Resources of the St. Walburg Area (73 F), Saskatchewan:* Map 18.

Christiansen, E. A. *Geology and Groundwater Resources of the Waterhen River Area (73 K), Saskatchewan:* SRC Map 19.

Haughton, D. R.; Smith, J. W. J. *Collection, Analysis and Computer-Based Documentation of Geochemical Samples in the Precambrian of Saskatchewan:* SRC Report 14.

Schreiner, B. T.; Alley, D. W.; Christiansen, E. A. *Quaternary Deposits of the La Ronge Area (73 P), Saskatchewan:* SRC Preliminary Map.

Whitaker, S. H. *Geology and Groundwater Resources of the Prelate Area (72 K), Saskatchewan:* SRC Map 16.

Whitaker, S. H. *Geology and Groundwater Resources of the Willowbunch Area (72 H), Saskatchewan:* SRC Map 20.

Whitaker, S. H. *Geology and Groundwater Resources of the Weyburn Area (62 E,F):* SRC Map 21.

REPORT OF THE DIVISION OF INDUSTRIAL SERVICES

I. S. Evans, Head

INTRODUCTION

The Division's broad objective has remained unchanged during the year. It is to increase the efficiency, effectiveness and so the profitability of industry operating within Saskatchewan. This objective is achieved by:

— making scientific and technical information available to industry on a free and confidential basis;

— fostering the use of scientific and technical information by industry;

— providing technical assistance to industry;

— promoting the use of industrial engineering and management science by industry;

— making the services of industrial engineers available to industry;

— engaging in information science;

— adding to Saskatchewan's industrial infrastructure;

— undertaking specific studies under contract.

In order to assist industry, the division provides these services.

Through the technical information service:

technical inquiries;
industrial engineering and management science;
technological developments.

Through the technical assistance program:

Assisting industry to obtain government assistance, to obtain financial assistance, to conduct in-house research and development;

A science-service library;

Specific studies undertaken under contract.

The Technical Information Service

The technical information service is a joint Saskatchewan Research Council and National Research Council effort through the Canadian Institute of Scientific and Technical Information Service. The increasing financial and technical support of the National Research Council is gratefully acknowledged.

Technical Inquiries

The technical inquiries section responds to specific requests from industry for information and advice. The response to these inquiries depends entirely upon the nature of the inquiry. This response varies from making the services of the local expert available to providing pertinent written information for the "routine" inquiry. Between these extremes lies the major inquiry. In a sample of 50 major inquiries it was found that 4000 pages of technical information were provided. This indicates very clearly that there is no dearth of technical information but it requires some considerable effort to provide the best information for the inquirer.

The breadth of the subject area on which the division is consulted continues to increase. In the past year the subject matter of the inquiries included scrubbing systems for pollution control, bacteria control in the food industries, wood preservation, testing procedures, sodium lamps, and antifreeze.

In order to obtain some idea of the value of the service to provincial industry, three companies of the hundreds served were asked to estimate the benefits derived from the service.

A manufacturer of fiberglass products making numerous replacements due to weathering under warranty requested assistance for the selection. Weathering tests were carried out on materials from several suppliers and a recommendation made. The company owner stated that the assistance was immediately worth $5,000 but that it was difficult to place a cash value on the long-term benefit of selling a good product.

A plastics manufacturer wished to experiment with some special additives. Processing of these additives into usable form was done by the Prairie Regional Laboratory of the National Research Council. This same manufacturer estimated that the value of services during the past two years to be

between $20-30,000 mainly in last resort trouble shooting.

The president of a prefabricated house company estimated that fairly continous consultation during the year had saved his company many thousands of dollars. During one visit to the plant the TIS engineer took with him an engineer from the division of building research of the National Research Council. The recommendations of this specialist were immediately implemented and have resulted in savings of $25,000 a year. More significant recommendations will be implemented in the near future.

PLANT IMPROVEMENT was required when this St. Gregor dance hall was converted to an aluminum window plant. SRC staff assisted with this activity.

Since it is impossible for the TIS staff to spend one day per year with each significant industrialist in the province it is essential that industry as a whole is reminded regularly of the existence of the service. This is the primary role of *The Catalyst*. During the year the following subjects were discussed:

The Re-Birth of Rural Mexico
Energy
Technologies
Profit Through Welding Technologies
Venture Capital
Ten Pertinent Questions
Long Range Planning
Fuel Gases

Industrial Engineering Program

The purpose of the industrial engineering program is to improve the efficiency and effectiveness, and therefore the competitive advantage, of industry by making the optimum use of its internal and external resources. The industrial engineering approach is directed towards the systematic design, installation, operation, and maintenance of an organization's operations which combine its basic resources (men, machines, markets, materials, money, and management) to achieve the corporate purpose.

The value of the industrial engineering program is reflected in industrial growth: more production, sales, and exports, as a result of higher operating efficiencies, with a resulting increase in new industrial jobs created. The program's internal confidential reports annually identify benefits in terms of new jobs created, cost reductions, and increased profits which average several hundred thousand dollars per industrial engineer.

Examples of the value of the division's industrial engineering program in 1974 are as follows:

— A concrete manufacturer required $200,000 for expansion. He reported that if he had not received our assistance in developing marketing and financial data, he would not have been able to obtain the necessary loan and would have been forced into bankruptcy because of a serious cash flow problem.

— Output in a recreational product factory dropped to one-half of the budgeted amount. The company was unable to correct the situation and abandoned plans for expansion. One of the division's industrial engineers assisted the company to reverse its productivity decline, take corrective action in the production management area, and develop new plans which made expansion possible.

— As the result of a complete operational review, an industrial engineer recommended significant changes in the layout of a Saskatchewan metals company which increased profits more than $50,000 per year, and created new jobs.

— The result of successfully implementing industrial engineering recommendations in a Saskatchewan manufacturing company was increasing 15 employees in 1970 to 100 in 1974.

— The application of some simple industrial engineering scheduling techniques and reallocation of men and machines in one small Saskatchewan manufacturing plant, resulted in production of its primary product increasing from one per week to more than five units per day.

During the year, under the industrial engineering program, a number of talks and seminars were presented, including a special seminar at the annual meeting of the Saskatchewan Chamber of

Commerce. Also, services were provided to the Prairie Implement Manufacturers Association. During the year, the Canadian Institute of Management, Saskatoon Branch, which the industrial engineering program helped establish, had its formal act passed by the Saskatchewan legislature.

Dr. Larry Steinmetz, University of Colorado, at the small manufacturing firm seminar.

In the fall, a special seminar entitled "Managing The Small Rapidly Growing Manufacturing Company" was sponsored and presented to presidents and general managers of about 25 Saskatchewan-owned manufacturing firms, representing sales of more than $75 million of Saskatchewan manufactured goods, and more than 2,000 employees.

During the year, the program's publication *Industrial Business Management* was distributed to approximately 4,000 senior managers in Saskatchewan. Subjects covered during the year were as follows:

- How to Sell Your Ideas To Management
- Eight Running Games For Executives
- Establishing Project/Program Priorities With PRIMA
- Achievement and Effectiveness
- Delegating Work and Responsibility
- Effective Industrial Advertising For Small Plants
- A Guide To Effective Financing
- Financial Industrial Incentives Catalog
- So You're A Real Whiz on Small Plant Management
- How To Make Your Family Business More Profitable
- Any Manager's Clear Responsibility
- Is Your Cash Supply Adequate?

Supplementing the above publication, several booklets were prepared for distribution. These included "$ell More Through Time Management", "Small Business Guidebook — 2nd Edition", and a pocket card entitled "Twenty Hints For Practical Time Management". Also, one paper was presented at a professional conference. ("Improve Your Personal Effectiveness Through Management By Emphasis", Alan Scharf. Annual Management Conference, American Institute of Industrial Engineers, July 1 and 2, 1974, Chicago.)

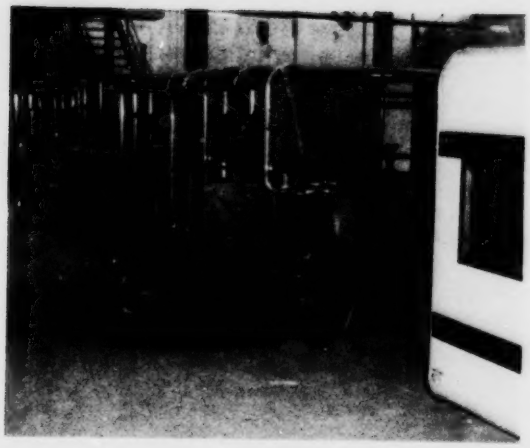
Some of the participants at the Oct. 24-25 seminar "Managing the Small Rapidly Growing Manufacturing Firm."

The program was short staffed during most of the year. As soon as appropriate additional staff can be obtained, the program will be increased with greater benefit to the province.

Technical Service For Industry

It was reported in 1973 that the Canadian Welding Improvement Bureau and the National Research Council had agreed to support financially and technically the employment of a welding specialist at the Council. The appointment was made in April 1974.

The specialist's activities in the period under review have been first to determine precisely the state of the art in the province and secondly to propose and implement some remedial action. Some 43 welding establishments have been visited and discussions have been held with the welding instructors at the Kelsey Institute of Applied Arts & Science and the Department of Labour's welder testing and apprenticeship branch. As a result of this survey it was found that the majority of welding supervisors have had no formal training in welding techniques, use of equipment, weldment design or the metallurgy of welding. This was also true of the professional engineers interviewed. The exceptions were the companies certified by the Canadian Welding Bureau.



PRODUCTION PLANNING and control strategies were subjects of discussion between SRC and this Regina manufacturer of aluminum campers.

All this leaves the responsibility for the production of good welds to the welders, the vast majority of whom have no qualifications and have had no training.

Many companies were therefore found to be:

— Using incorrect welding techniques
— Making poor weldments
— Over welding and casting materials
— Using expensive materials where cheaper materials would be adequate and in some cases better
— Using inefficient fabrication methods
— Using incorrect heat treatment procedures

By the way of example one company was shown how it could save $25,000 per annum by using less gas in its metal inert gas welding, and at the same time produce stronger welds.

The immediate task is to upgrade the technology used in a whole industry. Clearly without assistance and willing co-operation this borders on the impossible. The proposed solution is therefore to hold a number of welding appreciation courses for management. If management understands the nature and processes being used and the characteristics of a good weldment, they will much more readily apply the rules for good welding in their factories. When this is achieved upgrading courses for foremen and welders will be instituted.

A seminar entitled "Welding and Fabrication in Saskatchewan Industry" was presented by Mr. D. Glossop at the College of Engineering, University of Saskatchewan, on October 28, 1974.

The results of the welding survey indicate very clearly the necessity of establishing as soon as possible a "metals using" advisory group on the Council's staff. Such a group could immediately apply itself to existing problems such as metal and alloy selection, inspection, fabrication methods and failure analysis. Metals, however, are not the only materials used in industry. The metals group should rapidly become a materials group to give the same assistance in the non-metallic fields; for example, plastics, wood, glass, concrete and paint.

Two of the division's engineers have been engaged in assisting industry and under contract to companies. It is interesting to note that this assistance was requested by industry and is a measure of the division's value to industry. Failure analysis was undertaken on lifting apparatus for a government department following an accident, with positive results.

Technical Assistance Program

Assistance in Obtaining Federal Research and Development Support

Activity in this field was virtually suspended because the incumbent was on leave of absence until November 1974. There is still a general unawareness of the financial assistance available from federal sources. The growth and diversification of industry in Saskatchewan is dependent upon the exploitation of new technology which is the product of research and development. This project which seeks to increase the amount of research and development conducted by industry and in industry will be pursued vigorously in 1975.

LIBRARY STAFF handle microfilm items, 400 periodicals, 7,000 books and 10,000 pamphlets routinely, as well as 2,000 requests for special documents last year. Specialized library services are available to industry and government clients of the Council as well as its scientific staff.

The library continues its function of providing information support to the Council's research program and to provincial industry. Co-operation and efficient services from publishers, document distributors and other libraries maintains the library's ability to provide virtually any identifiable document to clients. Requests for documents from Council employees numbers over 2,000 per year. Users registered from University and industry during the year numbered over 20.

Access to specialized documentation sources and the use of new techniques for literature searching is becoming more important in finding efficiently pertinent information in an ever expanding labyrinth of published papers. Current developments in on-line retrieval systems are being carefully observed to determine application to our clients' needs.

Two moves of our stored material in one year has been disruptive to normal routine. Radical changes in the collection are not expected until the question of future space availability is resolved. Immediate space requirements will be met by acquiring as necessary back files on microfilm.

The library now distributes Council reports received to 18 libraries throughout the world, making the Council's reports available to abstracting and indexing services, thereby making the results of Council work widely available and generally more known than otherwise.

REPORT OF THE PHYSICS DIVISION

J. Maybank, Head

INTRODUCTION

Research activities in the physics division are primarily related to the two areas of environmental quality and of resource development, with several of the former projects being of particular relevance to agricultural activities as well.

The environmental research program is designed to provide answers to problems concerned with the understanding and best use of Saskatchewan's climatic environment, and with ameliorating, or adapting to, various harsh or detrimental aspects of it. Atmospheric quality and air pollution problems are investigated both as they affect living conditions and development, and as they interact with soil and water conditions and other aspects of the total environment. Studies on the atmospheric environment have led to benefits in the field of hydrology, agriculture, construction technology and renewable resource management. They form a necessary input into environmental assessments and impact undertakings. Specific research studies also relate to pollution abatement, land management, crop diversification, weather probability estimates and irrigation system design.

Resource development projects are designed to investigate reserves, correlate quality and recovery capability data, and provide guidance on resource management and optimal utilization. Much of this research is interdisciplinary and several of the projects are closely related to the work of other Council divisions. Again, such investigations as groundwater geophysics not only pertain to a resource development but are environmentally oriented, and the results are of concern to the agricultural sector of the provincial economy. The present scope of the research encompasses studies on Saskatchewan's groundwater and coal resources to provide for a fuller understanding of their development potential.

In addition to these research projects, the division maintains service laboratories for all council staff for electronics and precision instrument construction and repair. Maintenance and servicing of these and all purchased equipment is also provided when requested. In addition, the services of the two laboratories may, under contract arrangements, be made available for instrument construction and consulting for organizations outside the council.

During the year, significant completed work included the following:

(1) A detailed system for the computerized coding, storage and analysis of coal quality data. It is now being used to deliveate the provinces lignite resources and potential for their further development.

(2) An analysis of the province's requirements for remote sensing capability (both by aircraft and satellite) in the fields of agriculture, mineral resources, forestry and transportation, and of ways to meet these needs.

Several new opportunities have recently been established for special contractual and consulting work. These include a World Meteorological Organization request for a report on rain increase and prospects for agriculture by weather modification techniques, geophysical interpretation of a land slide for B.C. Hydro, and help in designing a new air sampler unit for SED Systems Ltd.

Saskatchewan's Climate

Renewed emphasis on agricultural climatology highlighted the past year's program. Plots adjacent to the Climatological Reference Station were used to provide data for the World Meteorological Organization's international wheat experiment. In addition, phenological data was collected from small plots of most filed crops for which the Saskatchewan Department of Agriculture makes variety recommendations.

A colored climatic map, containing data on monthly precipitation and temperature, annual frost-free season and precipitation frequency, and climatic extremes is in final stages of preparation. Council staff was again involved in preparing the climate section of the *Guide to Farm Practice*. The

CLIMATIC MEASUREMENT provides important baseline data for assessment at Saskatchewan environment. Karen Brander checks solar radiation information measured at SRC's Climatological Reference Station.

SOPHISTICATED MODELS such as the unit shown on the bench top demonstrate SRC's electronics capabilities. Don Barnett carries out tests on a prototype power system simulator which simulates, at normal power line frequencies, the behavior of the Saskatchewan Power Corporation system.

recently established Saskatchewan Committee on Agricultural Meteorology is chaired by J. Maybank while J. L. Bergsteinson continues as the province's representative on the Canada Committee on Agricultural Metorology.

Much of the climatic information for Saskatchewan is available at SRC in a computer-sensible data bank. Key records in the data bank have been employed for such purposes as studies of wind-wave interaction on lakes for Environment Saskatchewan, examination of corn growing potential for agricultural purposes and studies of temperature and precipitation regimes to support groundwater hydrology programs at Regina and Yorkton.

The outdoor test bench facilities of the Climatological Reference Station have been utilized by outside agencies in relation to tests of a solar heated grain dryer, tests of a rainfall simulator in relation to soil moisture buildup, incubation of grasshopper eggs and the survival of lichens on rock.

Major maintenance was carried out at the reference station during the year. This included replacement of the soil temperature sensors, recalibration of part of the solar radiation equipment, major overhaul of the air pollution monitor and minor building maintenance. A program of study of potash brine evaporation was reactivated. A program of regular measurement of soil moisture was instituted. Instrumentation to measure the gradient of atmospheric humidity is awaiting installation.

Remote Sensing

A study of potential applications of remote sensing to Saskatchewan problems, funded by Environment Saskatchewan, was prepared for the Saskatchewan Inter-Agency Committee on Remote Sensing. Since the report was prepared, SRC has maintained a watching brief on selected aspects of remote sensing. Chairmanship of the inter-agency committee has passed from Dr. T. P. Pepper, SRC director, to J. L. Bergsteinsson of physics division. Remote sensing techniques, using both satellites and aircraft can, in principle, rapidly provide information on such matters as crop acreages, development and diseases, field moisture conditions, forest operations, and snow pack growth, water content and melt rates. Many other uses are considered possible, but in every case it is necessary to combine surface observations with the remotely sensed data over an initial period in order to establish interpretation rules and sensitivity levels for the conditions being sought.

Reduction of Pesticide Drift

The pesticide study is supported in part by an Extramural Research Grant from Canada Agriculture, and is designed to study the amounts of herbicides and insecticides escaping the sprayed area and drifting downwind either as droplets or as vapour. From these findings it is possible to recommend ways to reduce the hazards to adjacent areas and susceptible crops or living areas and to improve the efficiency of the entire spray process.

PESTICIDE DRIFT is influenced by application equipment, spraying methods and meteorological factors. Keith Wallace sets up instruments to monitor drift at a Regina field site. This program is supported in part by Canada Agriculture.

Detailed analysis of the 1973 field trials was completed early in the year. The drifting fraction of 2 - 5 per cent was found to increase considerably with wind speed. It also varied with nozzle type and spray nozzle pressure. It was possible from the downwind samples of the drifting airborne material to estimate the total deposition that could be expected from regular form spray operations. The levels of 2,4-D to rapeseed could be reached under certain conditions. Ways of avoiding this are available, and in particular the results indicated significant drift reduction and considerable savings in herbicide used could be achieved through more uniform spray application.

Using more extensive field sampling equipment, a further series of 14 ground-spray trials was carried out this year in co-operation with Canada Agriculture staff at Regina. Additional nozzle and pressure combinations were tested at a wider range of wind speeds. Preliminary analysis suggests that while certain combinations may be equally suitable for use in light winds of 5-10 mph superior drift control is apparent for some nozzles when winds exceed 15 mph.

Following completion of the ground spray field work, a series of four aircraft spray trials was carried out at Kenaston. The sampling and analysis techniques were essentially the same, so that relative drift hazards could be assessed. It appears that initial drift from aircraft is roughly ten times that from ground rigs, but this factor decreases to roughly a 4 to 5-fold one by several swath widths downwind.

Analysis of 1973 results from the 2,4-D monitoring network indicated that overall concentration levels were comparable in most areas of the province, with large day to day fluctuations being a result of local spray operations. As a result, only one station was operated by the Council this year (at Saskatoon) and one by Canada Agriculture (at Regina). The monitoring program began early in June and due to crop lateness was extended to the end of July. Chemical analysis was more detailed and uniform than in previous years in an attempt to determine types of 2,4-D tnat were drifting. General levels were lower than in past years due partly to the phasing out of the butyl esters and partly to the longer spray season caused by variable and late crop development.

A final field trial series was carried out late in the season to compare aircraft applications of two formulations of 2,4-D. The work was carried out on a contract basis for a commercial firm and the results have been reported directly to them.

Air Pollution Abatement

Saskatchewan does not suffer from such major air pollution problems as some areas have, but those that do occur are frequently made worse by the cold, calm conditions that tend to prevail in the winter months. Furthermore, they are closely linked with soil or water pollution arising from the airborne material. For these reasons, the division has developed an interest in air pollution studies, for much of which there is a natural staff and equipment tie-in with the pesticide drift work.

During the year a special sample partitioner device was designed, constructed and tested under a research subvention from the Atmospheric Environment Service. Its purpose is to direct the air being sampled into one of four or more sampling units chosen by the particular wind speed or direction values at the time. In this way concentration levels of any pollutant may be assigned to specific wind conditions and the pollutant origin more readily traced.

ATMOSPHERIC ELECTRICITY TECHNIQUES to measure smoke plume dispersion are employed by Stan Shewchuk, shown setting up an electrostatic field mill. This method appears promising in the study of potash dust patterns.

A survey of dust pollution from grain elevators was carried out around two prairie villages under a contract from the Atmospheric Environment Service. Deposition rates, particle size and shape features, and composition were determined and related to weather conditions and the type of grain being handled at the local elevators. This research is designed to find whether potentially harmful effects may occur as grain handling becomes concentrated in fewer locations, and to recommend ways to reduce the levels.

As in the previous year, several small investigations of dust effluents and air pollution were undertaken on contracts for local industries, the results in each case were reported to the company and serve as the basis for determining the degree of dust control that may be required.

Groundwater Availability and Quality

The continuing objective of this program, which in the past was supported by ARDA, is to engage in applied studies to contribute to the technology of water well development, to increase the chance of finding aquifers and to aid in making information on groundwater more readily available. The main project in this area is the study of performance characteristics of large-diameter farm water wells.

Most of Saskatchewan's farms, villages, small towns and even a few cities (e.g. Regina and Yorkton) rely on wells to supply much of their water needs. Very little scientific work has, however, been done on the performance characteristics of shallow, large-diameter water wells. In Saskatchewan, such wells may be found in an area comprising an estimated 60 per cent of the southern half of the province. Many large-diameter wells in this area provide inadequate supplies of water, often producing water of poor quality. The total economic investment in these wells is high. Our investigations, related to shallow large-diameter wells, are emphasizing well performance, well construction and water quality with the main objective being to help solve farm water well problems. Specifically, one problem involves preventing extremely fine sand or silt from entering the well with the water. Tests on a specially built sand filter (see photo elsewhere in this report) are being planned.

During the last year, measurements have been recorded and the results analyzed for an instrument called the Multiple Program Sequenced Recording System (i.e. MPSRS). A report on the use and performance of this instrument is nearing completion. Basically, the purpose of this investigation is to measure deep earth temperatures to evaluate the flow of water through the soil.

Again this year, several requests have been received from drillers and farmers concerning borehole logging problems related to groundwater investigation and large-diameter well problems.

RELIABLE RECORDING of water levels is achieved with SRC designed and produced systems using a novel stepping motor arrangement. Rudi Heinze is assembling units capable of detecting level changes of a hundredth of a foot in -40 degree environment.

Lignite Coal Resources

The quality and occurrence of the province's lignite coal resources are vital inventory requirements for their optional development and use. A continuing co-operative program designed to provide and correlate this information is underway, involving the Canada Department of Energy, Mines and Resources, the Saskatchewan Department of Mineral Resources, and the Saskatchewan Research Council. The main purpose to date of the physics division's part of this work is to process the results of the chemical analysis of coal samples obtained from hundreds of sites during 1972 and 1973.

The processing of this data is continuing to be undertaken in co-operation with Drs. D. S. Montgomery and T. W. Tibbetts (EM & R). The coordination of site location data and the chemical analysis results is continuing to be undertaken in co-operation with Dr. S. H. Whitaker, geology division (SRC). A large effort is being directed toward creating a certified data-base. This is a collection of data which has been accurately and consistently edited and which render on magnetic tape. Over the past two years analytic information has been received from the Canada Department of Energy, Mines and Resources. The magnetic tape file now contains information on 2,198 samples from 290 sites. The computer-assisted procedures for maintaining the file are completed and are functioning on a routine basis. Information is being rapidly processed after it is received.

Data processing work, to construct a file of information on borehole information for the above coal program, is underway. The main emphasis is on building a file of geophysical data comprising measurements made during the "field work" portion of the coal resources program. This information will be used to help correlate the chemical with the geological information at each site and thereby assist the coal resources inventory.

Information and Computers

Much of the research in the area of geophysics has involved investigations of methods of computer handling, storage, retrieval and analysis of large bodies of data. Data projects have accounted for about fifty per cent of the effort in the geophysical activities this year. The main emphases have been on computer handling, storage and retrieval of information.

The main emphasis, as mentioned, has been in the area of lignite resources information handling. In addition, though, two functional computer-assisted procedures have been implemented successfully at the SRC. These procedures were designed and implemented with the co-operation of the Council's geology division. The geology division is vitalizing the procedures to: build files of testhole information which comes from the Sask. Dep't. of Agriculture's (FFIB) "testhole drilling assistance" program; and to build files of information on the uality of water at specific sites in Saskatchewan.

Recently, a new apparatus for digitizing graphs was completed. This device digitizes points on a chart and punches the values on paper tape. It will be used initially to convert information into a form suitable for computer use with the coal resources program. In general, however, the device will be useful in assorted data-processing applications which require scaled and measured distances to be taken from diagrams or charts. A photo of the digitizer, in use, is shown elsewhere in this report.

A project is currently underway to index literature holdings pertaining to the coal resources program in Saskatchewan. Citations are being coded and entered into a commercially available computer-assisted retrieval system called FAMULUS. The system has been used on other literature indexing projects in the physics division. It has been found to operate efficiently. Search and retrieval is largely based upon words or phrases found in various selected "fields". The greatest effort in literature indexing for computer retrieval systems is in choosing descriptor words which characterize a given article or report clearly and adequately. Benefits of this data processing are that access to specific reference material will be easier and that comprehensive searches can be made rapidly and with little cost.

Instrumentation Graphics

The purpose of this project is to complete and formalize the description and specifications for devices designed and built at the SRC. In the course of joint groundwater undertakings with the geology division, the need for specific analytical and monitoring devices has occurred. Some instruments are used regularly and therefore require "user" and "maintenance" documentation. Other devices have more general applications and require "technical" and "specifications" documentation. Through this project, documentation in the form of technical drawings (see figure), photographs and reports are produced. Completed documentation is available upon request.

Electronics Laboratory

During the year the electronics laboratory continued to provide consultation, design, fabrication and maintenance in support of the Council's research program and on a contractual basis to outside agencies.

A data tablet digitizing system was designed and constructed. This system records on punched paper tape co-ordinate pairs generated by a manually operated cursor traversing a flat tablet. In this manner, analog data in the form of recorder charts, maps, etc. can be converted into digital form for computer input and subsequent analysis.

An air sampler controller was designed and constructed. This control detects wind direction and opens one of four valves corresponding to that direction. In addition, a corresponding elapsed time indicator is energized. The resultant elapsed time readings totalize the sampling time from four wind direction. The controller also provides a time delay to prevent mechanical failure of the valves due to high repetition rates. This unit is designed to partition air being sampled according to its direction of arrival at the site, in order to trace more effectively the origin of air pollutants. A similar unit is under construction which will partition the air by wind speed ranges or turbulence conditions.

A contract was accepted from the Saskatchewan Power Corporation for design evaluation, construction and test of a network simulator. This simulator would model, in real time, the power distribution network. A prototype to test the fundamental principle has been constructed and tested successfully.

Precision Instrument Laboratory

During the past year, the activities of this laboratory were divided approximately equally between development of new instruments and the repair and servicing of existing equipment. In addition a small portion of time is allocated to improvement of laboratory facilities and machinery equipment.

A further requirement for 10 more level recorders was filled during the year; these were mostly for the geology division for some of their contractual investigations. At this time the advantages of the injection molding technique were demonstrated by the rapid additional production of all plastic components for 50 more recorders should they be required in the future. Considerable labour savings can be made in this manner.

INSTRUMENT MANUALS are vital to the construction, operation and maintenance of complex instrumentation like the SRC-developed water level recorder. Ed Perkins (foreground) uses photographic techniques while Richard Reich (background) employs conventional drafting to document the new instrument.

The air sampling equipment for pesticide drift studies was considerably increased with the construction of six more mobile air sampling stations. Related work included the servicing and modification of the sampler motors and improvements to the meteorological observing system.

Three trigger mechanisms were constructed for incorporation on the sidewall sample truck. These are designed to provide reliably-located material from the drilling program for subsequent analysis.

A recent contract was arranged with two commercial firms for the construction of rotary burner ovens. These are to be used in the provinces uranium industry for the fusion of ore samples prior to analysis.

Reports and Publications

Bergsteinsson, J. L., in *Fire Studies in the Mackenzie Valley*. Rowe, J. S.; Bergsteinsson, J. L.; Padbury, G. A.; Hermesh, R. Dept. of Northern Affairs and Indian Development. 73-74-61.

Bergsteinsson, J. L. *Remote Sensing for Saskatchewan*. P 74-4.

Bergsteinsson, J. L. *Wind Patterns at Selected Saskatchewan Stations*. P 74-9.

Dyck, J. H. *Some Applications of Borehole Logging to Quaternary Research: A Study in Southern Saskatchewan*. Geo. Exploration II, 233-247 (1973).

Dyck, J. H.; Perkins, E. H. *Heinze Gas — volugraph for Recording Gas Evolved Versus Time*. Can. J. Earth Sciences II. 565-569 (1974).

Grimsdale, J. L. *Meteorology: Literature Indexing and Information Retrieval Using the Famulus Computer System*. P 74-6.

Heinze, R.; Olm, O. J.; Perkins, E. H.; Dyck, J. H. *Report of an Invention: Hoimeaga Stepping Motor and Stepping Motor Controller*. P 74-5. (Confidential).

Mahoney, V.; Dyck, J. H.; Meneley, W. A. *Simpson, Sask. Piezometer Study: Graphs of Water Level Versus Time*. P 74-1.

Mahoney, V.; Dyck, J. H.; Meneley, W. A. *Simpson, Sask. Peizometer Study: Tables of Water-Level Elevation, Piezometer Number and Date*. P 74-2.

Maybank, J.; Yoshida, K.; Grover R. *Droplet Size Spectra, Drift Potential, and Ground Deposition Pattern of Herbicide Sprays*. Can. J. Plant Science. 54, 541-546 (1974).

Maybank, J.; Yoshida, K. *Droplet Deposition and Drift from Herbicide Sprays: Analysis of the 1973 Groundrig Trials*. P 73-16.

Reich, R.; Dyck, J. H. *A Study of Water Production from Shallow Farm Wells at Two Sites in Saskatchewan*. P 73-15.

Yoshida, K.; Maybank, J. *Determination of Discharge Rates and Particle Size Distributions of Dust from Potash Drier Systems*.

Yoshida, K.; Maybank, J. *Atmospheric Grain Dust Contamination in the Vicinity of Prairie Grain Elevators: Part 1, Dust Fall Survey*. P 74-7.

Yoshida, K. *Analysis of Dust Emission from a Pellet Mill*. P 74-8.

Yoshida, K.; Shewchuk, S. R. *Drift Measurements of Aerially-applied 2,4-D Estemine Spray*. P 74-11.

THE UNIVERSITY PROGRAM

SCHOLARSHIPS

The Government of the Province of Saskatchewan offers graduate research scholarships tenable at either the University of Saskatchewan or the University of Regina. The purposes of the awards are to assist graduate students to prepare for careers in scientific and industrial research and to create interest in the development of resources and techniques that will advance the development of the Province. The Council conducts the selection of the awards.

Awards valued at $3400 for the year beginning October 1, 1974 were made to:

I. T. Serada, Biology, University of Saskatchewan
D. Holdner, Chemistry and Chemical Engineering, University of Saskatchewan.
M. Nasr, Chemistry and Chemical Engineering, University of Saskatchewan.

GRANTS IN AID

Since its creation in 1947, the Saskatchewan Research Council has provided grants to University of Saskatchewan applicants for applied research in the sciences. Twenty-one grants totalling approximately $84,000 were awarded in 1974 to applicants at both the University of Saskatchewan and Regina University. This includes $10,000 grants from each of the Saskatchewan Mining Association and Environment Saskatchewan towards the study entitled *Distribution and Fate of Potassium Chloride Dustfall in the Environment* undertaken by staff of the Department of Soil Science, University of Saskatchewan and of the Saskatchewan Research Council.

DEPARTMENT OF ANIMAL SCIENCE

Peas and Pea Fractions in Milk Replacers for Calves

under the direction of
Professor J. M. Bell

Renewed interest in the growing and processing of field peas is a part of the continuing program of diversifying Saskatchewan's agricultural base. New and less expensive protein sources for use in milk replacers for raising dairy calves are greatly needed and increasingly so with the recent cost-price squeeze confronting dairy producers. The work here reported pertains to a research project involving the testing of pea flour, pea protein concentrate derived from pea flour and containing 50 to 60 per cent protein, and concentrate treated in various ways to improve its digestibility by the newborn calf.

In order to demonstrate that pea protein can be used effectively by older calves, pea flour was fed to calves over two weeks of age. This pea flour resulted from pinmilling dehulled peas, but was not otherwise processed. Rations containing pea flour at levels to provide 0, 25 or 50 per cent of the dietary protein, rather than from milk products, were fed successfully. Calves grew at entirely acceptable rates and there were no significant differences in gain between calves fed milk protein only and those where half of the protein was of pea origin. No digestive upsets or palatability problems were encountered. We conclude that unprocessed pea flour is an acceptable product for inclusion in milk replacers fed to calves over 15 to 20 days old, and that the inclusion of pea flour could result in a reduction of price of the final replacer.

A further experiment has been initiated where calves are fed "pickled" colostrum to three weeks of age and then are fed a milk replacer where pea protein concentrate (rather than pea flour) is being used as a source of 25 per cent of the dietary protein.

Laboratory studies were carried out on pea protein concentrate (PPC) in order to determine the effects of subjecting PPC to acid or heat treatments on the *in vitro* digestibility of the product. Based on these studies, and on previous work from this department, several pre-treatments were selected for study by *in vivo* feeding trials. These pre-treatments of PPC were, (a) proteolytic enzyme; (b) amylolytic followed by proteolytic enzymes; (c) cooking followed by proteolytic enzymes and (d) no pre-treatment. Rations of each of these four types of PPC were compounded so that 25 per cent of the dietary protein was of pea origin. These diets are currently being fed to newborn calves and are being compared against an all-milk replacer. Preliminary results suggest that the pre-treatments have been effective in increasing the digestibility of PPC in newborn calves, but that the pretreated PPC is not yet as digestible as top quality milk products.

The valuable assistance rendered by Dr. G. I. Christison, professional research associate and Mr. Jas. Graham, summer student assistant is acknowledged.

Publications

Bruce E. Harvey. 1974. Pea flour in milk replacers for young dairy calves. Master of Science thesis. University of Saskatchewan.

DEPARTMENT OF BIOLOGY

An Extensive Study of the Factors Affecting the Occurrence of Iron Bacteria in Surface and Ground Waters

under the direction of
Professor D. R. Cullimore

Emphasis has been placed upon three important aspects of the iron bacteria. These are (1) the development of a simple field test for indicating the presence of iron bacteria in water, (2) a study of the nutrition of iron bacteria particularly with respect to iron and manganese, and (3) an initial investigation of simple physical methods of controlling the growth of iron bacteria in 4-inch wells. All three aspects have progressed well.

A simple field test has been developed and preliminary field trials have been conducted

through the Family Farm Improvement Branch. Seven reactions can occur in the three-day incubation period, two of which are indicative of iron bacteria being present. The remaining reaction patterns are caused by other bacteria including sulphide-producing (corrosive) bacteria and an investigation is currently underway to determine specifically the cause of these reactions. These initial trials do reveal that iron bacteria are widespread in the province's groundwater systems even where problems due to these organisms are rare.

Nutritionally, the iron bacteria studied have been found to preferentially take-up manganese rather than iron, thus indicating that in future water studies, manganese concentrations may be more critical to the growth of these bacteria than iron. Studies are still being conducted to determine the concentrations involved.

The growth of iron bacteria has proved to be very difficult to control under field conditions by chemical means. An extensive survey has been conducted into the physical methods of control with emphasis on the use of elevated temperatures. The thermal sensitivity of cultures of iron bacteria has been established and an apparatus developed (Dr. E. Tward, Physics and Astronomy Department, University of Regina) to use in 4-inch wells to control iron bacteria. Initial laboratory field trials indicate the method to be feasible with a low initial capital outlay and running costs.

This project is valuable to the province of Saskatchewan in that it provides a simple field test whereby iron bacteria may be detected in surface and ground waters. It also provides a potentially efficient and low-cost method of treatment for wells with problems related to the excessive growth of iron bacteria, and indicates the nutritional conditions required to support such growths of the organisms.

The grantee would like to thank the following people for their assistance in this project: Mrs. A. E. McCann (laboratory supervisor), Miss J. Anweiler, Mr. B. McCashin, Miss D. Bean, and Mr. M. Riley; also Mr. F. Snell and Mr. L. Cocks of the Family Farm Improvement Branch, Saskatchewan Department of Agriculture for their advice and assistance.

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING

Utilization of Fly Ash in the Treatment of Pulp and Paper Mill Effluents.

under the direction of
Professor N. N. Bakhshi

Power plants in Saskatchewan produce large amounts of fly ash which at present is being stockpiled. A small portion of this material is being used in the manufacture of cement and as land fill, however, the problem of disposing large quantities of fly ash still remains unsolved. The purpose of this investigation was to use fly ash to treat the effluent from pulp mills. If this treatment is successful, it might open up a whole new avenue for profitable disposal of fly ash.

Effluent was obtained from the bleach plant of the Prince Albert pulp mill. It was found that when the effluent was treated with acidified fly ash, about 94 per cent of the color-bodies were removed. The treatment was carried out at 200 rpm and for a mixing period of two hours. After mixing the effluent and fly ash, the resulting sludge settled down quickly and a clean supernatant liquid could be separated easily. In addition no problems were encountered in filtration of this slurry. On the other hand, similar treatment with fly ash alone did not give encouraging results.

At present work is continuing towards understanding the mechanism of colour removal by fly ash. Three hypotheses are under consideration:

(i) adsorption of color-bodies on the fly ash;
(ii) chemical reactions between the available constituents in the fly ash and the organics in the effluent and,
(iii) both (i) and (ii).

Mr. Randy Gillies, a graduate student, is working on this project. We are grateful to Dr. Brad Gunn for his assistance on this project.

Publications

M. S. Nasr, R. G. Gillies, N. N. Bakhshi and D. G. Macdonald, "*Colour Removal of Pulp Mill Effluents with Fly Ash*". Paper accepted for presentation at the joint American Inst. of Chem. Eng. and Environmental Protection Agency meeting, Chicago, May 4-8, 1975.

N. N. Bakhshi, "*Treatment of Tar Sands Tailings with Fly Ash*". Paper presented at the 167th meeting of the American Chemical Society, Mar. 31-Apr. 4, 1974, Los Angeles.

N. N. Bakhshi, R. G. Gillies and Pradeep Khare. "*Treatment of Tar Sands Tailings with Fly Ash*". Submitted for publication to *Environmental Science and Technology*".

Chemical Analysis of Birch Bark (Betula Papryifera).
under the direction of
Professors J. M. Pepper and P. J. Smith

It has long been recognized that local birch bark is capable of resisting microbial decay for long periods of time. This project is concerned with the isolation and characterization of the chemical(s) in the bark which are believed to be responsible for the high degree of resistance to microbial attack. As well, this research program includes a testing of these chemicals for possible biological activity using several different fungi. Such compounds, if found to have antimicrobial action, may be useful for commercial utilization as a preventer of wood rot.

Birch bark, dried and ground, was extracted with various organic solvents. The extracts were examined using column chromatography. The following compounds were isolated in pure form and identified using spectroscopic techniques and by comparison with authentic samples; betulin (35 per cent by weight of the dried bark), allobetulin (trace), lupeol (< 1 per cent), β-sitosterol (< 1 per cent).

Betulin, allobetulin, acetyl oleanolic acid and β-sitosterol were tested, using several different concentrations, against five different fungi. It was found that all the compounds tested inhibited growth to some extent. Betulin, however, inhibited to the greatest extent. For example, betulin at 5×10^{-3} M inhibited the growth of the culture, *Foames ignarious*, to the extent of 90 per cent over six days. It is of interest to note that betulin, approximately 35 per cent by weight of the dried bark, occurs by a far greater amount in the bark of a birch tree than any other type of tree bark.

Mr. N. Johnson, summer research assistant, was associated with this project. A paper entitled, "Chemical Analysis of Birch Bark", by N. W. Johnson, J. M. Pepper and P. J. Smith was presented at the 57th Chemical Conference of the Chemical Institute of Canada in June, 1974, Regina, Saskatchewan.

Research in Fluid-Solid Systems
under the direction of
Professor C. A. Shook

Pipeline transportation of solids such as mineral concentrates and coal is an important alternative to conventional methods such as rail and road transport. Factors tending to increase the credibility and effectiveness of solids pipelines should promote efficient and rational transportation policies. The Engineering Division of the Saskatchewan Research Council has contributed substantially to the body of technical knowledge which is used in the design and operation of such pipelines.

As part of this general program of study, the behaviour of slurry pipelines after shutdown has been studied theoretically and experimentally. The effects of line length and slope have been considered because current design procedures restrict permissible slopes to values well below those which can be used with oil or gas pipelines. This restriction can artificially increase the capital cost and reduce the competitive effectiveness of a slurry pipeline.

The studies have shown that there is no rational basis for the restriction of the slopes of operating pipelines to any arbitrary value below the angle of internal friction of the settled bed. Tests conducted with pipes of modest (two-inch) diameter show that the behaviour of long sloped pipes can be satisfactorily predicted from experiments conducted with short pipe sections. Theoretical studies are to be undertaken to allow conclusions to be extended to much larger pipelines for which laboratory studies are impractical. These studies should reduce substantially the capital cost of slurry pipelines operating in difficult terrain such as the Canadian shield of northern Saskatchewan.

Assistants on this project were D. McLeod and J. Rollins.

Publications

Shook, C. A., Rollins, J. and Vassie, G. S., *Sliding in Inclined Slurry Pipelines at Shutdown*, Can. J. Chem. Eng., *52*, 300-305 (1974).

DEPARTMENT OF CIVIL ENGINEERING

Landslides in the Saskatoon Area
under the direction of
Professor E. K. Sauer

The first stage of a field drilling program has been completed as a joint effort between the Department of Civil Engineering at the University of Saskatchewan and the Geology Division of the Saskatchewan Research Council. The drilling defined the geology along the east river bank at Saskatoon from the Broadway Bridge to Beaver Creek a distance of about 10 miles of almost continuous landslides. A preliminary geotechnical appraisal has been made. The interpretation of the geology was done by Dr. E. A. Christiansen of the Saskatchewan Research Council.

A paper defining the state of the art and the problems involved with urban development will be published in February.

Study of Foundation Conditions in the Downtown Area of Saskatoon.
under the direction of
Professor W. G. Watt.

The South Saskatchewan River, 25th Street and Avenue B enclose an area of intense development of multi-storied buildings forming the downtown section of the City of Saskatoon. Existing buildings are usually replaced with larger ones which will transmit heavier loads to the underlying soil. To determine the type and size of foundation which will prevent structural damage and cracking of finishes requires knowledge of the variation of the soil compressibility over the whole building location.

Large portions of property have only small sections abutting the lanes which are not built upon and these are paved parking stalls and loading door entranceways. There are still considerable overhead wires which prevent the erection of the masts on drilling rigs used to explore soil conditions. Thus it is difficult to get much information from any one site.

The objective of this study is to provide detailed geological and engineering framework for the bearing strata underlying the downtown area.

Property owners of buildings built before the advent of soil testing and prospective buyers of real estate would be able to predict soil conditions on their property, by interpolating known conditions under their neighbors' structures. The study will not eliminate soil testing on individual sites because of the deposits. However, if anomalous conditions were discovered during drilling the engineer would be alerted to expand the exploration program. This is less costly than design changes during construction.

Three deep holes to bedrock and nine shallower holes into the overlying glacial till comprise the basis for the geological report. Samples taken from the shallow holes were tested to determine the engineering properties of the soil.

Support was given by the geology division of the Saskatchewan Research Council in the drilling of the deep holes and in the geological interpretation of the data from them. The PFRA was helpful in supplying equipment to drill the shallow holes. Undergraduate students hired on the STEP, YES and PEP programs helped with initial surveys, laboratory testing and computer analysis.

Mr. Walter Shtenko, graduate student, directed all phases of the work and is including the data and analysis in his Master's thesis. He has been Chief Geotechnical engineer for B.C. Railways since December 1973 and the analysis and writing has been relegated to a home study project. However progress, though slow, is continuous and the thesis should be completed in April 1975.

It is proposed to publish the thesis in the form of a report and present a gift copy to the City of Saskatoon.

DEPARTMENT OF DAIRY AND FOOD SCIENCE

Incidence and Detection of Abnormal Manufacturing Milk in Saskatchewan.
under the direction of
Professor G. Blankenagel

Approximately a year ago, shortly after several hundred producers of farm-separated cream began shipping manufacturing milk, it was noticed that in several dairy herds the incidence of udder infections was fairly high. A research grant from the Saskatchewan Research Council made it possible to collect a number of milk samples and locate herds with mastitis problems.

During a four-month period from May until August, 1974, 840 samples of industrial milk were

analyzed by means of two different gel tests to detect abnormal milk. Of those, only 15 per cent were found to be satisfactory, 74 per cent showed traces, while 11 per cent contained excessive leucocyte counts. The results were made available to the Saskatchewan Department of Agriculture.

Since abnormal milk ususally has a different salt concentration, 534 samples were also analyzed for the percentage of chloride. The results of these tests indicated that 58 per cent of the samples were within the normal limit, while 42 per cent showed a high salt content.

DEPARTMENT OF ELECTRICAL ENGINEERING

Programming Additions to the Geographic Information System

under the direction of
Professor A. R. Boyle

The funds allocated to this group by SRC were mainly spent on summer student support in program and hardware design.

The group as a whole has been working on a system of considerable interest to the province. It is concerned with man/computer handling of cartographic data and also of 'attribute' data relative to locations, routes and areas. With its visual display facilities it is a small but powerful tool for planning whenever the problem is of a geographic nature. Such problems may be in the areas of socio-economics, transportation, land-use or geology or geochemistry, for example. The Department of Northern Saskatchewan is supporting the development of such a system for their management control functions.

The present state of the overall system is almost completed as far as normal cartographic display and manipulation are concerned, although extra facilities are added from time to time as the need arises. The cartographic system has recently been extended to applications in photogrammetry by liaison with a team in Germany and this is causing interest with other Departments in Saskatchewan. The attribute data handling aspect is now nearing completion as far as Version 1 is concerned and we hope that the first operation tests will take place in early 1975.

While these systems were designed for 'location specific' they are nevertheless also very useful for more normal data storage and retrieval problems and some of these aspects will be included.

Many other geographic information systems as this is, are designed to carry out the full modelling operation within the computer and advise the user. This is not the aim in the one described; it is to present data rapidly and in an easily assimilated form to the real user so that that person can carry out his own mental modelling. This group regards this approach as more acceptable to many users.

The work carried out during the summer was the setting up of an interactive contouring capability as part of the cartographic system. Locations of various values (heights, density, per cent Cu etc.) are first displayed and after a request for a contouring operation and the specification of a contour interval, the approximate contour levels appear on the screen within about two seconds. These may then be smoothed and possibly modified by the user; in other words he can add his own subjective judgements. This program appears to have considerable use for hydrology, geochemistry where we are liaising closely with Dr. D. Haughton of the SRC, and even for socio-economic values. As soon as time allows this program will be implemented into the main cartographic system for general usage.

The writer of this report has, during this year, given papers on these matters at the International Cartographic Association Conference in Madrid and at the American Society of Photogrammetry Meeting in Washington, D.C. At the moment he is involved in the organization of a world wide conference of Automated Cartography to be held at the U.S. Geological Survey National Center near Washington D.C. in December, and in the writing of the part of a book on geographic information systems concerned with systems to be published by the International Geographic Union in 1975.

DEPARTMENT OF GEOLOGICAL SCIENCES

Biostratigraphy of the Cretaceous White-Speckled Shales in Saskatchewan

under the direction of
Professor W. G. E. Caldwell

Rocks of Late Cretaceous age form the bedrock surface of fully one-half of Saskatchewan, and the two formations most widely used to correlate the Late Cretaceous rock sequences are the white-speckled shales. For many years, the white-speckled shales have been used as stratigraphic and structural markers in assessing the amount of collapse that has taken place in the 'potash belt' of the province as a result of solution and removal of the underlying prairie evaporite formation. In the

last year or two, the white-speckled shales have assumed an increased economic significance: oil is being produced from them in the adjacent plains of Alberta, and an important radiometric anomaly discovered in the Pasquia Hills of Saskatchewan suggests a concentration of uranium in the shales of this area. In the borderlands with Manitoba, the white-speckled shales contain known oil shales which well may become economic in the near future. The stratigraphy of the white-speckled shales has been poorly understood, however, and an attempt now is being made to refine the stratigraphy using assemblages of fossil foraminifera.

Six distinct foraminiferal assemblages have been isolated from the white-speckled shales and from the beds above, below and between them. By plotting the distribution of the assemblages in two lines of section, one WNW-ESE across the middle of the province and the other NNW-SSE in the borderlands with Manitoba, it has been possible to show that the white-speckled shales are bounded and separated by disconformities. In the 'potash belt' of central Saskatchewan, bevelling by the disconformity between the white-speckled shales has brought them together to form a single formation. In the past, this formation has been interpreted wrongly as the lower white-speckled shale only.

The only pelagic foraminiferal faunas in the entire cretaceous system of the Canadian Great Plains are found in the white-speckled shales. Because pelagic foraminifera have been found to be among the most reliable of stratigraphic indices, it is important that these faunas be described systematically and compared to similar faunas known to exist in adjacent regions. A good beginning now has been made to this important phase of the study.

Professional research associate B. R. North and graduate student R. McKellar have been engaged (in part) in the investigation.

Publications:

North, B. R. and Caldwell, W. G. E., 1974, Foraminiferal faunas in the Cretaceous System of Saskatchewan: *in The Cretaceous System in the Western Interior of North America*, Geol. Assoc. Canada, Special Paper 13 *in press*.

McNeil, D. H. and Caldwell, W. G. E., 1974, The *Ostrea beloiti* beds: a Cenomanian time-stratigraphic unit in the Western Interior of Canada and the United States: Geol. Soc. America, Absts. with Prog., Ann. Meeting (Miami), p. 867.

Petrology of the Boundary Intrusions, Saskatchewan; Stable Isotope Geochemistry of the Amisk Carbonates.

under the direction of
Professor R. W. Forester

In 1946, Stockwell recognized a diverse group of supposedly related intrusions, in the vicinity of Flin Flon, to which he gave the name boundary intrusions. A detailed study of these intrusions has been carried out, in order to determine whether or not the boundary intrusions constitute a single cogenetic set of igneous rocks, and their relationship to major periods of deformation which have affected the Flin Flon ore body and surrounding country rocks.

Utilizing the field relationships, petrography, major element chemistry, and structural petrofabric features of the boundary intrusions, an internally consistent subdivision of these rocks has been established. In order of emplacement (oldest to youngest), these are (1) an olivine-free, metamorphosed mafic group, commonly amphibole-bearing; (2) a group of felsic dike rocks and minor intrusions, and (3) well preserved olivine-bearing ultramafic and gabbroic rocks that are characterized by cumulate textures. A graduate student, E. C. Syme, is now completing an M.Sc. thesis based on the above-described research. This work has led to a better understanding of the geological setting in the vicinity of Flin Flon-Saskatchewan.

Another research investigation, supported in part by the Council's grant, has been initiated. Our stable isotope laboratory is now capable of analyzing carbonates for $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios. Volcanic rocks of the Amisk Group in Saskatchewan have been sampled, and their carbonate phases are now in the process of being analyzed in order to determine (1) the origin of the fluids that deposited these minerals, and (2) the origin of the carbon in the volcanics and in the Flin Flon ore body.

Development of Seismic Reflection Methods for Subsurface Mapping in the Precambrian Shield.

under the direction of
Professors Z. Hajnal and M. R. Stauffer

Seismic relfection techniques have been used for mapping subsurface structures for several decades in the search for petroleum. The study discussed

here has been undertaken in an attempt to develop the seismic reflection method as a tool for mapping subsurface structures and prospecting in the highly folded and faulted Precambrian Shield. Previous attempts by other workers have not been successful, for a wide variety of reasons.

To date we have been successful in mapping several structures in subsurface near Flin Flon, Manitoba, including a fault, an unconformity, and the Flin Flon ore-bearing rhyolite horizon, opening up the possibility of using seismic reflection as a deep-penetration prospecting tool. Methods of deep prospecting are urgently required if we are to continue to use metals as the basis of our civilization.

Various aspects of the seismic properties of Shield rocks have been studied, and one of the more important findings has been the decrease in seismic velocity of near-surface rocks, a phenomenon that must be taken into account in any future seismic prospecting project. Experiments to determine the optimum type of energy source and the best geometry of the geophone array are not complete. To date, arrays of 10-foot deep holes loaded with 2-5 sticks of Geogel explosive, and located at various places adjacent to the geophone line appear to give the best results for relatively low cost.

Future work will concentrate on improving the energy source, developing rapid standard techniques, and attempting to map poorly defined geological structures.

We expect to be able to publish the results of work done to date by the spring of 1975.

Field Studies of Microseismic Energy Emission.
under the direction of
Professor M. S. King

The occurrence of clay seams in the evaporite formation adjacent to the ore in several Saskatchewan potash mines often presents problems in strata control. These clay seams in some cases are responsible for local failure of the mine roof. A method for predicting such potentially dangerous roof falls is to monitor the microseismic energy released by the rock in areas where strata control problems exist.

A laboratory study in the Department of Geological Sciences of the emission of microseismic energy by samples of potash has shown that a considerable amount of energy is released during the period immediately prior to failure. The object of the research supported under this project is to relate the results of the laboratory study to the prediction of roof failure underground. Results of the research programme are expected to assist in determining the optimum safe system of mining potash in areas where roof falls are prevalent and probably to predict the state of stress in mine pillars.

Equipment necessary to monitor the emission of microseismic energy underground has been designed and constructed at the University of Saskatchewan. After preliminary tests in a local potash mine had been successfully completed in 1972, the equipment was employed in a second potash mine to monitor the stability of a mine opening. Results of these tests indicated that the number of microseismic events increased slightly when reloading of the opening due to adjacent mining occurred. However, twenty-four hours before the roof of the opening under observation collapsed, there was a sharp increase (by a factor of 1,000) in the rate of microseismic events recorded. Microseismic events due to the mining machine and due to normal pillar unloading and reloading could be distinguished from those due to an impending roof fall.

Research is continuing of the prediction of roof falls in this potash mine. A second set of microseismic equipment has been designed to operate in small-diameter boreholes deep within a mine pillar. This equipment has been used during 1974 to monitor the emission of microseismic energy as the borehole within the pillar closes by creep. Preliminary results indicate that the rate of stress in the pillar at different depths in the borehole is related to the rate at which microseismic events are produced. It appears that these measurements will permit an estimate to be made of the build-up of stress within a pillar as the surrounding area is mined. This aspect of the research is continuing.

A former graduate student, Mr. A. Leuschen, is completing a M.Sc. thesis based on the original stages of the research described above.

COLLEGE OF HOME ECONOMICS

Treated Sewage Sludge as a Fertilizer

under the direction of
Professor A. K. Sumner

This project was undertaken to evaluate the safety of treated sewage sludge as a fertilizer for horticultural crops. Many cities including Saskatoon have recently installed sewage treatment plants. It has been suggested that the resulting sludge be disposed of as a dilute nitrogen fertilizer for horticultural crops. However, the large amounts of heavy metals in the sludge may create a health hazard if they translocate into the horticultural crops.

Treated sewage sludge from the Saskatoon plant was added to a sandy loam up to maximum rates equivalent to one ton per acre. Carrots and lettuce were grown in treated and untreated soil in a greenhouse. Soil and plant samples were analyzed for mercury, zinc, cadmium and lead using the atomic absorption method.

The treated sewage sludge contained cadmium — 8 ppm, zinc — 767 ppm, lead — 40 ppm and mercury — 11 ppm which ranged from 10 to 175 times the level in the untreated soil. However, even when the sludge was added to the soil at a rate of one ton per acre, the increase in these heavy metals in the soil was insignificant and the level remained relatively constant during the growing period. The cadmium, zinc, lead and mercury levels in the carrots and lettuce grown on untreated and treated soils were similar and were all within levels considered to be safe.

Assistance is being provided to the recently completed Newfield Seeds Limited pilot plant at Nipawin on the development of field peas as an important high protein crop for Saskatchewan. An extensive research program is underway to determine the effect of a series of moisture levels and temperatures on the storage life of pea flour, pea protein concentrate and pea starch. Factors being evaluated are microbial growth and types, enzymatic deterioration of fats and the development of offensive odors and tastes over a period of up to six months.

The economical dry milling and protein concentration process for field peas produces by-product pea starch containing about 2 per cent protein. It is planned to study some of the physical and functional properties of pea starch containing various low levels of protein in order to develop markets for this product.

Graduate students and staff involved in these projects are Mrs. Marilyn Nielsen, Mrs. Linda Whalley and Miss Linda Gracey. Assistance is provided by the Saskatchewan Research Council, Saskatchewan Department of Public Health, Canada Agriculture Research Station, National Research Council and the chemistry department and dairy and food science department of the University of Saskatchewan.

Publications

Saha, J. G., R. H. Burrage, Y. W. Lee, M. Saha and A. K. Sumner. *Insecticide Residues in Soil, Potatoes, Carrots, Rutabaga, Wheat Plants and Grain following Soil Treatment with Dyfonate.* Can. J. Plant Sci. In press.

Gracey, L. M. 1974. *Heavy Metal Uptake by Vegetables Grown in Soil Containing Treated Sewage Sludge.* Thesis, College of Home Economics, University of Saskatchewan. 30 pp.

DEPARTMENT OF HORTICULTURE SCIENCE

Fertility and Cultural Studies with Irrigated Vegetable Crops.

under the direction of
Professor D. H. Dabbs

The objectives of this continuing study have been stated previously. However, in general, the purpose has been to develop more precise guidelines for growers of irrigated vegetable crops in Saskatchewan. In 1973 and 1974 the entire field and greenhouse effort was directed toward fertility and hollow heart problems of the Netted Gem potato. The potato is the most important commercial vegetable crop in this province at the present time and hollow heart is periodically a serious problem with this variety.

Hollow heart incidence in the field plots was again very light in 1974 and no definite trends were obtained from additions of nitrogen to 350 pounds per acre, phosphorous to 100 pounds per acre and potassium to 100 pounds per acre on an irrigated soil that was already relatively rich in these three elements. Likewise, no definite trends were obtained from greenhouse potassium and boron experiments.

With the root temperature studies, however, trends were apparent. Three water bath temperatures (5, 10, and 15° C) were used in greenhouse studies. One-third of the potato plants remained at a given temperature throughout the trial while the other plants were interchanged with the other two temperatures (one-half of the exchange based on the flowering date at each temperature and considered separate treatments).

None of the plants grown at 5 degrees C throughout the experiment or until blossom time showed any browning. When exchanged earlier because of the advanced blossom date in the two higher temperatures very mild brown fleck was noted in 5 percent of the tubers transferred to 10 degrees C and the same percentage, but a definite brown patch was noted at 15 degrees C.

Plants grown at 10 degrees C either throughout, or exchanged, showed 5 percent brown fleck in some of the treatments, but no trend was established.

When the 15 degree C treatments were considered, up to 100 percent symptoms were obtained in replicates. When they remained throughout the growing season at 15 degrees C the average percentage infection was 34.47. When moved to 10 degrees C at blossom time this was reduced to 14.28 percent and when moved to 5 degrees C this was further reduced to 12.0 percent. When exchanged later than first bloom because of slower blooming at the lower temperatures the percentage dropped to 22.72 when exchanged with 10 degrees C, but the plants remained so long in the higher temperature that when they were exchanged with the first blooming 5-degree material there was really no reduction in percentage symptoms compared to those that were not exchanged.

From these preliminary temperature trials it would appear that high temperature, rather than low temperature, as commonly thought, is causal. It would further appear that 10 degrees C is close to the threshold temperature and that tuber initiation time (overlaps blossoming) is the critical time.

Additional root temperature, potassium and boron trials will be conducted in the greenhouse prior to the end of the present fiscal year.

Selection and Progagation of Late-Blooming Saskatoons.

under the direction of
Professor S. H. Nelson

In the spring of 1973 a number of late-blooming Saskatoon berry clones were marked for later collection of propagation wood. The original survey was made by air to pick out potential large populations of Saskatoon bushes while they were still dormant. During a three-week period from the very early blossom stage to the early fruit formation stage, these populations were visited and the area walked to do the selection of individual late blooming clones. Good sized populations were examined in an area bordered by the Eagle Hills (Prongua) on the west, Prince Albert National Park and Sturgis on the north, the Manitoba border on the east, and Yorkton and Dundurn on the south. In all, 133 clones were selected as late-blooming clones in the populations of any given area.

The propagation wood was collected in August and these selections are presently budded in a nursery. They will be ready for planting out for further observation in the spring of 1976.

Although frost is one factor that affects Saskatoon production, it is very obvious that other factors are also involved from this year's observations. No late frosts were encountered this year, but the general fruit set across the province was poor. Isolated good crops on individual clones were encountered at widely separated points while the rest of the bushes in the area were set up poorly. No similarity in topography or other physical features could be observed (i.e. Redberry Lake — exposed area on shoreline, Prince Albert National Park — woodland habitat, southeast of Kamsack — gravelly ridge, Lake Lenore — sheltered ravine, and south of Bradwell — a slough edge).

This initial population should prove to be a valuable gene resource for further selection and breeding of the Saskatoon bush to develop suitable varieties for annual commercial production.

SASKATCHEWAN INSTITUTE OF PEDOLOGY

Evaluation of Soil Contamination in the Vicinity of Potash Refineries

under the direction of
Professors D. A. Rennie, S. R. Bettany, E. de Jong and A. K. Ballantyne.

The scope and extent of this environmental monitoring program carried out in the vicinity of each of the ten operating potash refineries in the province is summarized below.

Six of the 40 benchmark soil monitoring sites surrounding each refinery were sampled in the fall of 1974; all sites that were sampled were located within a radius of 1-1/2 miles from the refinery in accordance with the reduced monitoring program initiated in 1973. The composite samples taken from each benchmark site to a depth of 120 cm are presently being processed.

During the period under report, data summaries covering soluble and exchangeable Na, K, Ca and Mg, soluble Cl and SO_4, the saturation moisture percentage, pH, and electrical conductivity of the saturation extract were prepared and distributed to each of the mines included in the program.

Representative samples of cereal and oil seed crops were taken in June, July, and again in August from sites adjacent to each of the Department of the Environment's 12 dustfall jars located at varying distances from each of the refineries. Composite soil profile samples were also taken from each of the crop sampling sites to a depth of 90 cm. Both soil and crop samples taken in this survey will be analyzed primarily for chloride content. This program, which was initiated in 1972, has, on the basis of annual data summaries, shown that chloride levels in the crop and soil samples taken within a one-mile radius of the refineries are considerably higher than those at further distances from the mine. The pattern of chloride levels in the vegetation is, in general, related to the dustfall chloride levels monitored by the Department of the Environment. Following completion of the data obtained in 1974, a systematic analysis and evaluation of the data obtained for wheat, oats, barley, rape and flax samples will be carried out.

Soil samples were taken to a depth of 210 cm from the nine saltdust treatments (receiving from 0 to 15 tons of saltdust/acre) from the field research plot located near Laura, Saskatchewan. The plot was in summerfallow during the past growing season.

This study to date has demonstrated that the chlorides move relatively rapidly downward and, at the present time, in excess of 50 per cent of the chlorides have moved below the 210 cm depth. In contrast, the majority of the potassium is retained in the 0 to 15 cm zone, while exchangeable calcium and magnesium displaced by the potassium are moved to lower depths. The majority of the added K has remained in the exchangeable form and very little has been irreversibly fixed by the clays.

All data obtained in the monitoring programs is stored in a computer data file. During the year under report, estimates of the chloride distribution in selected soils typical of those found in the potash corridor were calculated, assuming various levels of dustfall, and under a range of climatic conditions. Attempts are being made to develop a computer model capable of describing the daily movement of soluble salts as affected by precipitation, water use by the crop, and capillary movement of water in the soil. The model will initially be tested against weekly measurements of Cl content in the 0-1, 1-2, 1-4 and 4-8 inch depth of the soil on the university's Goodale farm obtained during the 1973 and 1974 growing seasons.

High altitude (33,000 and 17,000 feet above sea level) imagery was obtained on June 23 for each of the ten potash refinery areas. Black and white 70 mm photography in the green, red, near infra-red and far infra-red was obtained in addition to false color infra-red and true color photography on a 9-inch format. This imagery provides official records of crop and soil conditions, and surficial water distribution in the vicinity of each mine area. Prints have been made available to each of the 10 potash refineries.

Publications

A. K. Ballantyne, 1974. The movement of salts and the effects on cereal yields resulting from the application of potassium refinery dust to the soil surface. Can. J. Soil Sci. 54: 45-51.

INSTITUTE OF SPACE AND ATMOSPHERIC STUDIES

Solar Ultraviolet Radiation

under the direction of
Professors D. J. McEwen and E. H. Llewellyn

The objective of the research is to measure the level of solar ultraviolet radiation reaching the earth's surface and its variability with time and atmospheric conditions. Most of the solar radiation at wavelengths less than 3200 A° is prevented from reaching the ground by the layer of ozone which envelops the earth although a small amount does penetrate. An excess of this ultraviolet radiation is harmful to nearly all forms of life and is particularly hazardous in that it causes skin cancers.

The sky brightness over the wavelength region 3000 to 4000 A° is recorded daily at Saskatoon at local noon with a scanning spectrometer to measure its variation with season and cloud cover. The relation between ozone depletion and increases in ultraviolet radiation depends on a number of factors but in general the percentage increase in radiation below 3200 A° is believed to be about twice the decrease in ozone concentration. The ozone concentration is coupled to the 11-year sunspot cycle but is perturbed by other factors such as the introduction of pollutants into the stratosphere.

The uv radiation measurements underway will be extended to determine the total uv radiation

reaching the earth from both direct sunlight and through atmospheric scattering. The knowledge of the relation between the total uv radiation and the ozone abundance will permit assessment of effects of these variabilities for both human life and plant growth.

Interpretation of these ground based measurements of incident ultraviolet radiation will be aided materially by solar spectral measurements made at altitudes above the ozone layer with a similar instrument on two stratospheric balloon flights sponsored by the Atmospheric Environment Service during the past summer. Two further flights over Saskatchewan are scheduled in 1975.

Dr. A. Y. Ung, professional research associate, has been involved in this project. Technical assistance is being provided by Mr. H. T. Meredith; Mr. L. Murdock, an engineering student, is assisting in data collection and analysis.

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Zuk, B. O.	B.E., B.A., P.Eng.

THE SASKATCHEWAN RESEARCH COUNCIL

FINANCIAL STATEMENT

Year Ended March 31, 1974

To the Directors of
The Saskatchewan Research Council

AUDITOR'S REPORT

Pursuant to Section 20 of The Research Council Act, being Chapter 406 Revised Statutes of Saskatchewan, 1965, I have examined the balance sheet of The Saskatchewan Research Council as at March 31, 1974, and the statement of operations and operating surplus for the year then ended. My examination included a general review of the accounting procedures and such tests of accounting records and other supporting evidence as I considered necessary in the circumstances.

I am unable to verify unbilled shareable costs reported under that caption on the balance sheet as the eligibility of expenditures incurred under the Federal-Provincial cost sharing agreement for the fiscal period April 1, 1972 to March 31, 1974 has not been reviewed by the Provincial and Federal authorities.

In my opinion, subject to any adjustments to unbilled shareable costs and to operating surplus which may occur after the eligibility of expenditures incurred has been reviewed, these financial statements present fairly the financial position of the council as at March 31, 1974 and the results of its operations for the year then ended, in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Regina, Saskatchewan,
July 26, 1974.

W. G. Lutz, C.A.,
Provincial Auditor.

THE SASKATCHEWAN RESEARCH COUNCIL

NOTES TO FINANCIAL STATEMENTS

March 31, 1974

1. Fixed Assets:

(a) During the year the Council changed its policy from recording in the fixed asset accounts all equipment with cost of $50 or more acquired during the year to recording all equipment with cost of $100 or more. This change in policy resulted in approximately $3,000 or purchases being expensed when in prior years they would have been recorded as fixed assets.

(b) The Council follows the policy of removing from the fixed asset accounts all equipment which has:

— become obsolete during the year
— been sold during the year
— been in service for ten years.

2. Unbilled Shareable Costs:

Under the terms of a two year agreement with the Federal government agency administering the Agricultural Rehabilitation Development Act, the Council has incurred expenditures of approximately $897,000 in the fiscal period April 1, 1972 to March 31, 1974. Current year expenditures of approximately $497,000 are included in Statement 4 (Statement of Expenditures).

The agreement allows the Council to recover from the Federal government agency one-half of all eligible expenditures.

A 1973 advance of $175,000 from the Provincial Treasurer has been applied to the amount receivable under this agreement, reducing the recoverable amount from $448,665 to $273,665.

M121

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Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1974
(with comparative figures at March 31, 1973)

ASSETS

	1974	1973
Current:		
Cash	$ —	$ 99,713
Guaranteed savings deposit	102,599	144,034
Accounts receivable	265,420	93,381
Unbilled shareable costs (Note 2)	273,665	200,000
Prepaid expenses and deposits	11,805	9,985
Provincial grant receivable	54,996	—
Total current assets	$ 708,485	$ 547,113
Investments — Cost	$ 60,000	$ 60,000
Equity in Saskatoon Co-operative Association	$ 201	$ —
Fixed — Cost (Note 1)		
Laboratory equipment	$ 650,252	$ 558,995
Automotive equipment	114,909	107,681
Building	81,000	81,000
Furniture and fixtures	94,086	78,465
Shop equipment	48,059	46,169
Land	10,000	10,000
	$ 998,306	$ 882,310
	$1,766,992	$1,489,423

LIABILITIES AND EQUITY

	1974	1973
Current:		
Bank overdraft	$ 125,811	$ —
Accounts payable	172,981	72,510
Employee deductions payable	40,414	37,018
Advance from Provincial Treasurer (Note 2)	—	175,000
Deferred revenue and client deposits	47,818	—
Total current liabilities	$ 387,024	$ 284,528
Equity:		
Equity in fixed assets (Statement 2)	$ 998,306	$ 882,310
Operating surplus (Statement 3)	381,662	322,585
	$1,379,968	$1,204,895
	$1,766,992	$1,489,423

(see accompanying notes to financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1974

(with comparative figures for the year 1973)

	1974	1973
Equity in fixed assets, beginning of year	$ 882,310	$ 823,606
ADD:		
Fixed asset additions (Statement 4)	169,906	66,650
	$1,052,216	$ 890,256
DEDUCT:		
Fixed asset disposals		
— written off (Note 1)	$ 50,012	$ 437
— sold	3,898	7,509
Equity in fixed assets, end of year	$ 998,306	$ 882,310

(see accompanying notes to financial statements)

Statement 1

THE SASKATCHEWAN RESEARCH COUNCIL

BALANCE SHEET

March 31, 1974
(with comparative figures at March 31, 1973)

ASSETS

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(see accompanying notes to financial statements)

Statement 2

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EQUITY IN FIXED ASSETS

Year Ended March 31, 1974

(with comparative figures for the year 1973)

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Fixed asset disposals		
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— sold	3,898	7,509
Equity in fixed assets, end of year	$ 998,306	$ 882,310

(see accompanying notes to financial statements)

Statement 3

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF OPERATIONS AND OPERATING SURPLUS

Year Ended March 31, 1974

(with comparative figures for the year 1973)

	1974	1973
Revenue		
Province of Saskatchewan		
— grants	$1,212,266	$1,185,265
— Departmental contracts	653,659	299,044
	$1,865,925	$1,484,309
Government of Canada		
— Departmental grants	$ 114,000	$ 92,000
— Departmental contracts	180,053	161,100
— Cost sharing agreement	248,665	200,000
	$ 542,718	$ 453,100
Industry		
— grants	$ 10,000	$ 11,100
— fees for services	294,767	233,604
	$ 304,767	$ 244,704
Investment income	$ 11,596	$ 14,983
Proceeds on disposal of fixed assets	3,625	4,732
Other income	16,614	1,977
Total Revenue	$2,745,245	$2,203,805
Expenditures (Statement 4)	$2,604,682	$2,093,327
Research Grants (Statement 5)	81,486	69,250
	$2,686,168	$2,162,577
Surplus	$ 59,077	$ 40,958
Operating surplus, beginning of year	322,585	281,627
Operating surplus, end of year	$ 381,662	$ 322,585

(see accompanying notes to financial statements)

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1974

(with comparative figures for the year 1973)

	Admin.	Chem	Eng.	Geology	Industrial	Physics	1974 Total	1973 Total
Employee benefits	$ 8,081	$ 13,179	$ 13,679	$ 12,818	$ 6,973	$ 8,391	$ 63,121	$ 56,285
Fixed asset purchases	10,819	50,059	25,583	47,515	10,990	24,940	169,906	66,650
Other	31,581	10,399	39,903	88,385	16,959	16,366	206,093	187,559
Salaries	114,892	243,433	333,579	256,424	131,026	200,377	1,279,731	1,178,759
Supplies	14,538	14,466	29,801	38,348	17,525	16,849	131,527	109,267
Technical services	27,940	(10,930)	125,592	483,602	1,110	28,820	657,134	423,142
Travel and vehicle operation	7,408	5,167	23,485	38,183	10,540	12,387	97,170	71,665
	$215,259	$325,773	$592,622	$965,275	$195,123	$310,630	$2,604,682	$2,093,327

(see accompanying notes to financial statements)

Statement 3

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF OPERATIONS AND OPERATING SURPLUS

Year Ended March 31, 1974

(with comparative figures for the year 1973)

	1974	1973
Revenue:		
Province of Saskatchewan		
— grants	$1,212,266	$1,185,265
— Departmental contracts	653,659	299,044
	$1,865,925	$1,484,309
Government of Canada		
— Departmental grants	$ 114,000	$ 92,000
— Departmental contracts	180,053	161,100
— Cost sharing agreement	248,665	200,000
	$ 542,718	$ 453,100
Industry		
— grants	$ 10,000	$ 11,100
— fees for services	294,767	233,604
	$ 304,767	$ 244,704
Investment income	$ 11,596	$ 14,983
Proceeds on disposal of fixed assets	3,625	4,732
Other income	16,614	1,977
Total Revenue	$2,745,245	$2,203,805
Expenditures: (Statement 4)	$2,604,682	$2,093,327
Research Grants: (Statement 5)	81,486	69,250
	$2,686,168	$2,162,577
Surplus	$ 59,077	$ 40,958
Operating surplus, beginning of year	322,585	281,627
Operating surplus, end of year	$ 381,662	$ 322,585

(see accompanying notes to financial statements)

Statement 4

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF EXPENDITURES

Year Ended March 31, 1974

(with comparative figures for the year 1973)

	Admin.	Chem.	Eng.	Geology	Industrial	Physics	1974 Total	1973 Total
Employee benefits	$ 8,081	$ 13,179	$ 13,679	$ 12,818	$ 6,973	$ 8,391	$ 63,121	$ 56,285
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Travel and vehicle operation	7,408	5,167	23,485	38,183	10,540	12,387	97,170	71,665
	$215,259	$325,773	$592,622	$965,275	$195,123	$310,630	$2,604,682	$2,093,327

(see accompanying notes to financial statements)

Statement 5

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF GRANTS FOR RESEARCH PROJECTS

Year Ended March 31, 1974

	1974	1973
University of Saskatchewan — Saskatoon Campus		
Pea Protein as a Protein Source	$ —	$ 3,193
The Culture of Medicinal Plants	—	3,975
Sedimentary Strata of the Prairies	900	900
Helium-4 Mass Spectrometry for Uranium Exploration	1,459	1,330
Pollution of Soil, Water, etc. by Pesticide Residues	5,000	4,000
Photochemical Degradation of Pesticides, etc.	3,000	3,000
Hydrogen Reduction of Sodium Sulphate	3,233	3,382
Field Studies of Microseismic Energy Emission	3,817	4,000
Genetic Aspects of the Flin Flon Ore Body	—	3,000
Irrigation and Fertilizer Studies — Vegetable Crops	—	3,298
Soil Contamination and Crop Damage from Potash Refineries	14,033	14,047
Research in Fluid-Solids Systems	3,500	3,500
Stratigraphic Studies in Cretaceous Rocks	2,602	3,000
Algae Cultured in or upon Saskatchewan Lakes	—	2,991
Production of Pure Inorganic Salts	—	3,472
Structure Determination of Diallate Herbicide Isomers	—	1,600
Chemical Analysis of Birch Bark	3,000	1,657
Study of Foundation Conditions in Downtown Area of Saskatoon	2,990	2,300
Proterozoic Archean contact in the vicinity of Hanson Lake Road	3,444	4,000
Remote-sensing of moisture stress, weed composition, and salt accumulation	3,067	2,763
Genetical control of Mosquito	—	112
Programming Additions to the Geographic Information System to Facilitate Use with Geophysical and Geological Data	1,350	—
Peas and Faba Beans in Milk Replacers for Calves	3,019	—
Culture of Medicinal Plants	1,956	—
Petrology and Stable Isotope Geochemistry of the Boundary Intrustions, etc.	1,424	—
Utilization of Fly Ash in the Treatment of Pulp and Paper Mill Effluents		
and Paper Mill Effluents	3,004	—
Geotechnical Analysis of a Valley Crossing at Arm River	3,000	—
Milk Manufacturing in Saskatchewan	1,976	—
Fertility and Cultural Studies of Irrigated Vegetable Crops	3,712	—
	$69,486	$69,520
Regina Campus		
Thermal Properties of Salts	$ 3,000	—
An Evaluation of the Origins of Iron Bacteria found in Saskatchewan Soils and Water	4,500	—
Analytical and Physico Chemical Studies on Herbicides	3,000	—
Preliminary Study of Alkali and Alkali Earth Metals in Sask. Evaporites	1,500	—
	$12,000	—
Total	$81,486	$69,520

Statement 5

THE SASKATCHEWAN RESEARCH COUNCIL

STATEMENT OF GRANTS FOR RESEARCH PROJECTS

Year Ended March 31, 1974

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Total	$81,486	$69,520

CREDITS

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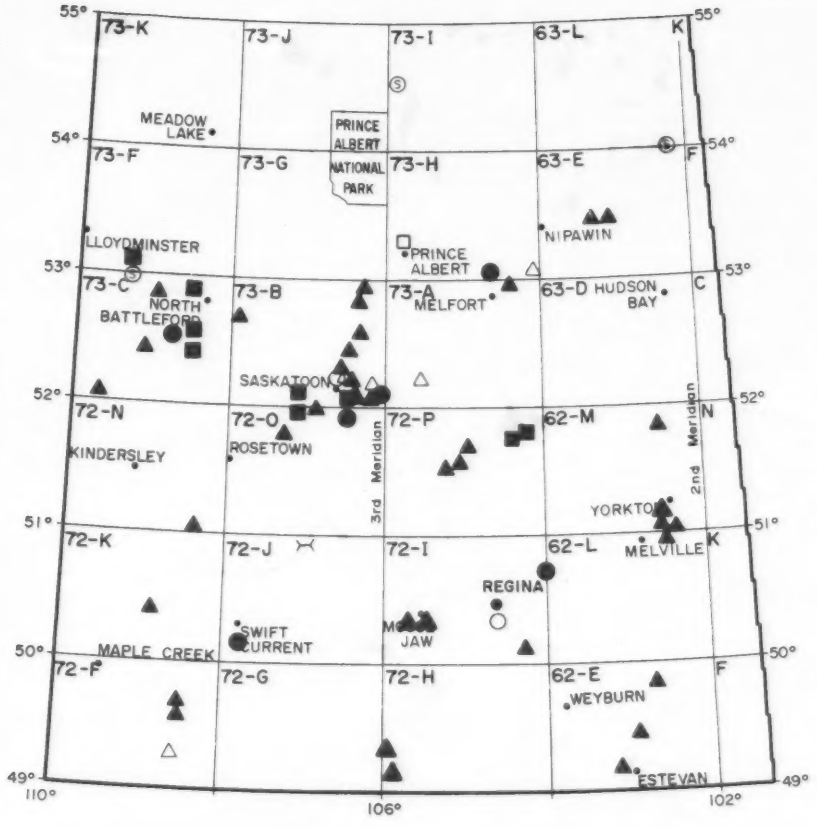
NOTES

LOCATION OF SASKATCHEWAN RESEARCH COUNCIL FACILITIES



EXPLANATION

- ▲ Observation well
- Ⓢ Sewer and water study
- ○ Pesticide sampling site
- △ Spray freezing site
- ● Slough study
- I Ice crossing study
- ■ Watershed